Key

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.

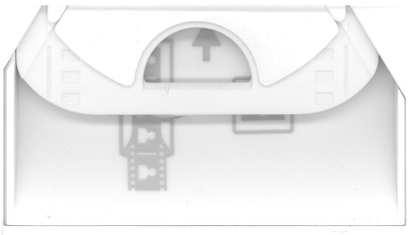
$$\text{Mass \%} = \frac{4.73g}{135g} \times 100 = 3.50\% \text{ salt}$$

↖ this has both!

(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.

$$\frac{425}{425+x} \times 100 = 40.0\% \qquad \frac{425}{425+x} = .400 \qquad \frac{425}{.400} = 425 + x \qquad \frac{425}{.400} - 425 = x$$

$$637.5g = x \ H_2O$$



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.

$\text{Molarity} = \frac{\text{moles}}{\text{liter}}$ so ...

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

Molarity = 0.288 moles / 1.50 L = 0.192 M solution

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

molar mass of NaCl: 23.1 + 35.5 = 58.6

$\frac{\text{Moles}}{\text{L}}$ $\quad \frac{24.3\text{ g} / 1\text{ mol}}{2.45\text{ L} / 58.6\text{ g}} = .169\text{ M NaCl}$ (same as $\frac{\text{mol}}{\text{L}}$)

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

Molarity X volume in liters = moles

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

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

Molarity X volume in liters = moles

Na 23.0, Cl 35.5, 58.5

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

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

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