Concentration of Solutions

- the amount of solute dissolved per specific amount of solvent or solution.

- can be measured in several ways:

(1) Molarity = $\frac{\text{number moles of solute}}{\text{L of solution}}$

$M = \frac{n}{V}$

Ex (1) What is the molarity of a solution made by dissolving 17.20 g H_2O_2 in 1.45 L of solution?

M = ?
n = .5057 mol
V = 1.45 L

$17.20\,g\left(\frac{1\,mol}{34.0136\,g}\right) = .5057\,mol$

$M = \frac{.5057\,mol}{1.45\,L} = .349\,mol/L$ or $.349\,M$

(2) What is the molarity of a solution made by dissolving 63.41 g of sodium hydrogen carbonate ($NaHCO_3$) in 225 mL of solution?

M = ?
n = .7548 mol
V = .225 L

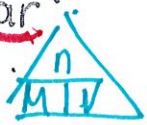
$n = 63.41\,g\left(\frac{1\,mol}{84.0058\,g}\right) = .7548\,mol$

$M = \frac{.7548\,mol}{.225\,L} = 3.35\,mol/L$

(3) What is the volume of a solution made by dissolving 18.00 g $CaCO_3$ in enough water to make a .800 Molar solution? $M = n/V$

M = .800 mol/L
n = .1513 mol
V = ?

$18.00\,g\left(\frac{1\,mol}{118.941\,g}\right) = .1513\,mol$



$V = \frac{n}{M} = \frac{.1513\,mol}{.800\,mol/L}$

$V = .189\,L$

(4) What mass of Li_2SO_3 was dissolved in 300. mL of solution to make a 1.11 Molar solution?

M = 1.11 mol/L
n = ?
V = .300 L

$n = M \cdot V$
$n = (1.11\,mol/L)(.300\,L)$
$n = .333\,mol$

$.333\,mol\left(\frac{93.9329\,g}{1\,mol}\right) = 31.3\,g$

Dilutions

↳ adding more solvent to decrease the concentrations

$$M_1V_1 = M_2V_2$$

Ex (5) What volume of 1.50 Molar NaOH is needed to create .600L of a 1.00 Molar solution?

(V_1 = ?, M_1 = 1.50 M, V_2 = .600 L, M_2 = 1.00 M)

$(1.50M)V_1 = (1.00M)(.600L)$

$\frac{(1.50M)V_1}{1.50M} = \frac{.600M\cdot L}{1.50M}$

$V_1 = .400L$

(6) You have 75.0 mL of a .900 Molar H_2SO_4 solution. You add enough water to create a new solution with volume of 125. mL. What is the new molarity?

(V_1 = 75.0 mL, M_1 = .900 M, V_2 = 125. mL, M_2 = ?)

$(.900M)(75.0mL) = M_2(125mL)$

$\frac{67.5M\cdot mL}{125mL} = \frac{M_2(125mL)}{125mL}$

$M_2 = .540M$

(7) You need 60.0 mL of a .250 Molar K_2SO_4 solution. In your cabinet you have a bottle of solution with a concentration of .850 Molar. What volume of the original solution do you have to use?

(V_1 = ?, M_1 = .850 M, V_2 = 60.0 mL, M_2 = .250 M)

$(.250M)(60.0mL) = (.850M)V_2$

$\frac{15.0M\cdot mL}{.850M} = \frac{(.850M)V_2}{.850M}$

$V_2 = 17.6mL$

(2) Molality = $\frac{\text{number moles of solute}}{\text{kg of solvent}}$

$m = \frac{n}{kg}$

Ex. (8) Determine the molality when 36.0 g NaCl is dissolved in 1.00 kg of water?

(solute: 36.0 g NaCl → convert to mol; solvent: 1.00 kg of water)

$m = ?$

$n = .616mol$

$kg = 1.00kg$

$n = 36.0g\left(\frac{1mol}{58.445g}\right) = .616mol$

$m = \frac{.616mol}{1.00kg} = .616\ mol/kg$ or $.616m$

(9) What is the molality when 16.94 g $BeCl_2$ are dissolved in 1500. g of water?

solute: mol; solvent

$m = ?$

$n = .2120\ mol$

$kg = 1500.g = 1.500\ kg$

$n = 16.94\,g \left(\frac{1\ mol}{79.9042\,g}\right) = .2120\ mol$

$m = \frac{.2120\ mol}{1.500\ kg} = \boxed{.1413\ \frac{mol}{kg}}$

(10) 34.76 g of AlF_3 are dissolved in 250.g of ethanol. What is the molality of this tincture solution?

solute; solvent

$m = ?$

$n = .4139\ mol$

$kg = 250.g = .250\ kg$

$n = 34.76\,g \left(\frac{1\ mol}{83.9776\,g}\right) = .4139\ mol$

$m = \frac{.4139\ mol}{.250\ kg} = \boxed{1.66\ \frac{mol}{kg}}$

(11) How many kg of solvent are needed to dissolve 26.00g $K_2C_2O_4$ and make a 1.25 molal solution?

solute; m

$m = 1.25\ mol/kg$

$n = .1564\ mol$

$kg = ?$

$n = 26.00\,g \left(\frac{1\ mol}{166.214\,g}\right)$

$kg = \frac{n}{m} = \frac{.1564\ mol}{1.25\ mol/kg} = \boxed{.125\ kg}$

(12) What mass of CO is needed to make a .850 molal solution in 1600.g of water?

$n = .1564\ mol$

solute; m; solvent

$m = .850\ mol/kg$

$n = ?$

$kg = 1600.g = 1.600\ kg$

$n = m \cdot kg$

$n = (.850\ mol/kg) \cdot (1.600\ kg)$

$n = 1.36\ mol$

$1.36\ mol \left(\frac{28.01\,g}{1\ mol}\right) = \boxed{38.1\,g}$