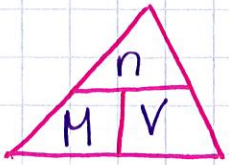
Measuring Concentration - Molarity

- Molarity = $\frac{\text{\# moles of solute}}{\text{Volume of the solution}}$ $\left(\frac{mol}{L}\right)$ molar M

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



Examples

(1) what is the molarity of a solution made by dissolving 2.64 mol of sodium chloride in .600L of solution?

M = ?
n = 2.64 mol
V = .600 L

$$M = \frac{n}{V} = \frac{2.64\,mol}{.600\,L} = 4.40\ mol/L$$

(2) what is the molarity of a solution made by dissolving 63.41g of $NaHCO_3$ in 0.225L of solution?

mass

M = ?
$n = \frac{63.41\,g}{} \left| \frac{1\,mol}{84.01\,g} \right. = .75\,mol$
V = .225L

$$M = \frac{.75\,mol}{.225\,L} = 3.33\ mol/L$$

(3) what volume of solution is needed when creating a 1.674 Molar solution of H_2SO_4 using 25.0g of H_2SO_4?

M = 1.674 mol/L
$n = \frac{25.0\,g}{} \left| \frac{1\,mol}{98.09\,g} \right. = .25\,mol$
V = ?

$$V = \frac{n}{M} = \frac{.25\,mol}{1.674\,mol/L}$$

$$V = .15\ L$$

?

(4) What mass of K_2CO_3 was dissolved in 0.350 L of solution to make a concentration of 1.50 Molar?

$M = 1.50\ mol/L$

$n = ?$

$V = .350\ L$

$n = M \cdot V = 1.50\ \frac{mol}{L} \cdot .350\ L$

$n = .53\ mol\ K_2CO_3$

$mass = \frac{.53\ mol \mid 138.21\ g}{\mid 1\ mol} = 73.25\ g\ K_2CO_3$

- How do you properly prepare a solution w/ a specific concentration?

STEPS

1. Measure the correct amount of solute
2. Dissolve the solute in water, keeping the volume less than the desired total volume of the solution.
3. Dilute the solution to the desired total volume.

- why do we do this?

Because solutes actually take up space (volume) If you start w/ the total volume of H_2O, your solution will end up at a higher volume at the end, which molarity will be lower than it should be.

Diluting a Solution

- What does it mean to dilute a solution?
  - adding more solvent

$n_{before} = n_{after}$ $\qquad n = M \cdot V$

$M_{before} \cdot V_{before} = M_{after} \cdot V_{after}$

$(M \cdot V)_{before} = (M \cdot V)_{after}$

$$M_1 V_1 = M_2 V_2$$

Examples & Practive

(1) What volume (V_1) of 1.5 M (M_1) sodium hydroxide is needed to create .600 L (V_2) of a 1.00 M (M_2) solution?

$M_1 = 1.5M$
$V_1 = ?$
$M_2 = 1.00L$
$V_2 = .600L$

$(1.5M)V_1 = (1.00M)(.600L)$

$\frac{(1.5M)V_1}{1.5M} = \frac{.600M \cdot L}{1.5M}$

$V_1 = .40 L$

(2) You have 0.00752 L (V_1) of a 12.0 M (M_1) sulfuric acid solution. You need to dilute it to a concentration of .500 M. (M_2) To what volume (V_2) do you need to dilute the solution?

$M_1 = 12.0M$
$V_1 = .00752 L$
$M_2 = .500M$
$V_2 = ?$

$M_1V_1 = M_2V_2$

$(12.0M)(.00752L) = (.500M)V_2$

$\frac{.09024 M \cdot L}{.500M} = \frac{(.500M)V_2}{.500M}$

$.18 L = V_2$

(3) You have made the perfect batch of sweet tea, 1.30 L (V_1) of delicious tea with a sugar concentration of 2.33 M. (M_1) Then your grandma from up north thinks it is too sweet and adds extra water. The volume is now 3.90 L. (V_2) What is the new concentration of your now diluted sweet tea?

$M_1V_1 = M_2V_2$

$M_1 = 2.33M$
$V_1 = 1.30L$
$M_2 = ?$
$V_2 = 3.90L$

$(2.33M)(1.30L) = M_2(3.90L)$

$\frac{3.029 M \cdot L}{3.90 L} = \frac{M_2(3.90L)}{3.90L}$

$.78M = M_2$

(4) A 12 oz (.621 L) (V_1) can of Coca Cola has 39.0 g (?) of sugar ($C_{12}H_{22}O_{11}$). Someone pours the can of Coca Cola into a pitcher of water and the volume is now 1.56 L. (V_2) What is the concentration of the diluted Coca Cola?

$n = 39.0g \left| \frac{1 mol}{342.34g} \right. = .11 mol C_{12}H_{22}O_{11}$

$M_1 = .11 mol / .621 L = .18M$

$M_1 = .18M$
$V_1 = .621L$
$M_2 = ?$
$V_2 = 1.56L$

$(.18M)(.621L) = M_2(1.56L)$

$\frac{.11 M \cdot L}{1.56 L} = \frac{M_2(1.56L)}{1.56L}$

$M_2 = .07M$

(5) You need 0.0100 L (V_2) of 2.25 M (M_2) hydrogen peroxide (H_2O_2) for a lab. You are given 0.0023 L (V_1) of a concentrated hydrogen peroxide solution. What is the concentration (M_1) of that solution originally? $M_1V_1 = M_2V_2$

$M_1 = ?$
$V_1 = .0023L$
$M_2 = 2.25M$
$V_2 = .0100L$

$M_1(.0023L) = (2.25M)(.0100L)$

$\frac{M_1(.0023L)}{.0023L} = \frac{.0225 M \cdot L}{.0023L}$

$M_1 = 9.78M$

How many moles of H_2O_2 are in the .0023 L of H_2O_2? What mass of H_2O_2 is in the solution?

$n = (9.78M)(.0023L) = .022 mol$

$mass = .022 mol \left| \frac{34.02 g}{1 mol} \right. = .75 g H_2O_2$