MOLARITY

As is obvious from its name, molarity involves moles.

The molarity of a solution is calculated by taking the moles of solute and dividing by the liters of solution.

$$Molarity = \frac{moles\ of\ solute}{liters\ of\ solution}$$

This is probably easiest to explain with examples.

Example #1 - Suppose we had 1.00 mole of sucrose (it's about 342.3 grams) and proceeded to mix it into some water. It would dissolve and make sugar water. We keep adding water, dissolving and stirring until all the solid is gone. We then made sure that when everything is well-mixed, there was exactly 1.00 liter of solution.

What would be the molarity of this solution?

$$Molarity = \frac{1\ mole}{1\ liter}$$

The answer is 1.00 mol/L. Notice that both the units of mol and L remain. Neither cancels.

A replacement for mol/L is often used. It is a capital M. So if you write 1.00 M for the answer, then that is correct.

Some textbooks make the M using italics (*M*) and some put in a dash, like this: 1.00- M. When you handwrite it; a good, old block capital **M** is just fine.

When you say it out loud, say this: "one point oh oh molar." You don't have to say the dash.

And never forget this: replace the M with mol/L when you do calculations. The M is just shorthand for mol/L.

Example #2 - Suppose you had 2.00 moles of solute dissolved into 1.00 L of solution. What's the molarity?

$$Molarity = \frac{2\ mole}{1\ liter}$$

The answer is 2.00 M.

Notice that no mention of a specific substance is mentioned at all. The molarity would be the same. It doesn't matter if it is sucrose, sodium chloride or any other substance. One mole of anything contains 6.022×10^{23} units.

Example #3 - What is the molarity when 0.75 mol is dissolved in 2.50 L of solution?

$$Molarity = \frac{0.75\ mole}{2.50\ liter}$$

The answer is 0.300 M.

Now, let's change from using moles to grams. This is much more common. After all, chemists use balances to weigh things and balances give grams, NOT moles.

Example #4 - Suppose you had 29.22 grams of NaCl and you dissolved it in exactly enough water to make 2.00 L of solution. What would be the molarity of the solution?

The solution to this problem involves two steps which will eventually be merged into one equation.

Step One: convert grams to moles.

Step Two: divide moles by liters to get molarity.

In the above problem, 58.44 grams/mol is the molecular weight of NaCl.

Dividing 29.22 grams by 58.44 grams/mol gives 0.50 mol.

Then, dividing 0.50 mol by 2.00 L gives 0.250 mol/L (or 0.250 M). Sometimes, a book will write out the word "molar," as in 0.250-molar.

Notice how the phrase "of solution" keeps showing up. The molarity definition is based on the volume of the solution, NOT the volume of pure water used. For example, to say this:

"A one molar solution is prepared by adding one mole of solute to one liter of water"

is totally incorrect. It is "one liter of solution" not "one liter of water."

Be careful on this, especially when you get to molality.

Practice Problems

1) Calculate the molarity of 25.0 grams of KBr dissolved in 750.0 mL.

2) 80.0 grams of glucose ($C_6H_{12}O_6$, mol. wt = 180. g/mol) is dissolved in enough water to make 1.00 L of solution. What is its molarity?

3) Calcuate the molarity when 75.0 grams of $MgCl_2$ is dissolved in 500.0 mL of solution.

4) 100.0 grams of sucrose ($C_{12}H_{22}O_{11}$, mol. wt. = 342.3 g/mol) is dissolved in 1.50 L of solution. What is the molarity?

5) 49.8 grams of KI is dissolved in enough water to make 1.00 L of solution. What is the molarity?