

Calculations

Lots of different formats for our answers, sometimes certain units are more helpful than others. Some branches of chemistry have a tendency to use one unit more than another.

N-40 – Solution Calculations

**Target: I can perform
calculations related to
solutions**

Assumptions to make...

UNLESS TOLD OTHERWISE...

- **Assume your solvent is water...it is the “Universal Solvent”**
- **Assume the density of your solution is the same as water (1mL = 1g)**

UNLESS TOLD OTHERWISE...

Mass Percent or Percent Composition

Ratio of masses expressed as a %

$$\text{Mass percent} = \left(\frac{\text{mass of solute}}{\text{mass of solution}} \right) \times 100$$

Parts per Million - ppm

Ratio of masses but not expressed as a %, but rather out of one million – used when very low levels are significant like for pollution.

$$ppm = \left(\frac{\text{mass of solute}}{\text{mass of solution}} \right) \times 1,000,000$$

Grams/Liter

Ratio of mass of solute to volume of solution. Easy for when measuring a solid solute dissolved in a liquid. Used to test solubility. “Quick and dirty” unit.

$$\text{Grams per Liter} = \left(\frac{\text{mass of solute}}{\text{Volume of solution}} \right)$$

Mole Fraction

Ratio of moles of solute n_A , to moles of total solution (solute n_A + solvent n_B)

$$\text{Mole fraction of } A = \chi_A = \frac{n_A}{n_A + n_B}$$

Molarity – the best one! 😊

Ratio of moles of solute to liters of solution. Similar to grams/L but converting it to moles lets us perform chemistry calculations better. Always trying to get to moles anyway!

$$\text{Molarity} = M = \frac{\text{moles of solute}}{\text{Liter of solution}}$$

Practice #1

734 grams of lithium sulfate are dissolved to make 2500 mL of solution. What is the Molarity?

Convert 734 grams of Li_2SO_4 in moles.

$$\frac{734\text{g Li}_2\text{SO}_4}{109.962\text{ g Li}_2\text{SO}_4} \times \frac{1\text{ mol Li}_2\text{SO}_4}{1\text{ mol Li}_2\text{SO}_4} = 6.68\text{ mol Li}_2\text{SO}_4$$

$$M = \frac{\text{Moles of solute}}{\text{Liters of solution}} = \frac{6.68\text{ mol}}{2.500\text{ Liters}} = 2.67\text{ M}$$

Practice #2

6.7×10^{-2} grams of $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_4$ are dissolved to make 3.5 mL of solution. What is the concentration?

When not told what unit to use, assume molarity!

$$\frac{6.7 \times 10^{-2} \text{ g}}{\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_4} \left| \frac{1 \text{ mol}}{\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_4} \right. = 1.51 \times 10^{-4} \text{ mol}$$
$$\frac{443.2 \text{ g}}{\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_4} \quad \text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_4$$

$$M = \frac{\text{Moles of solute}}{\text{Liters of solution}} = \frac{1.51 \times 10^{-4} \text{ mol}}{0.0035 \text{ Liters}}$$
$$= 0.0432 \text{ M}$$

Making Dilutions

When you take one more concentrated solution and take a small amount of it and dilute it down by adding more solvent.

$$M_1V_1 = M_2V_2$$

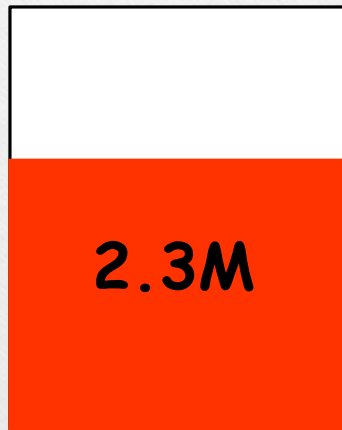
Practice #1

How much of a 2.3 M solution do you have to use in order to make 750mL of a 0.6 M solution?

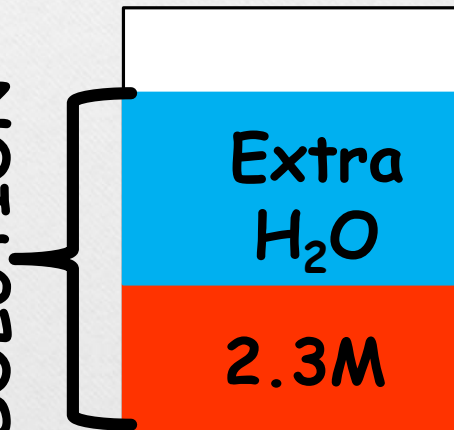
$$(2.3M)(V_1) = (0.6M)(750mL)$$

$V_1 = 195.65 \text{ mL}$ of the 2.3M solution is needed

How much water did you add???



750mL of 0.6 M SOLUTION



$$750 - 195.65 = 554.35 \text{ mL H}_2\text{O}$$

195.65mL of the STRONGER STUFF