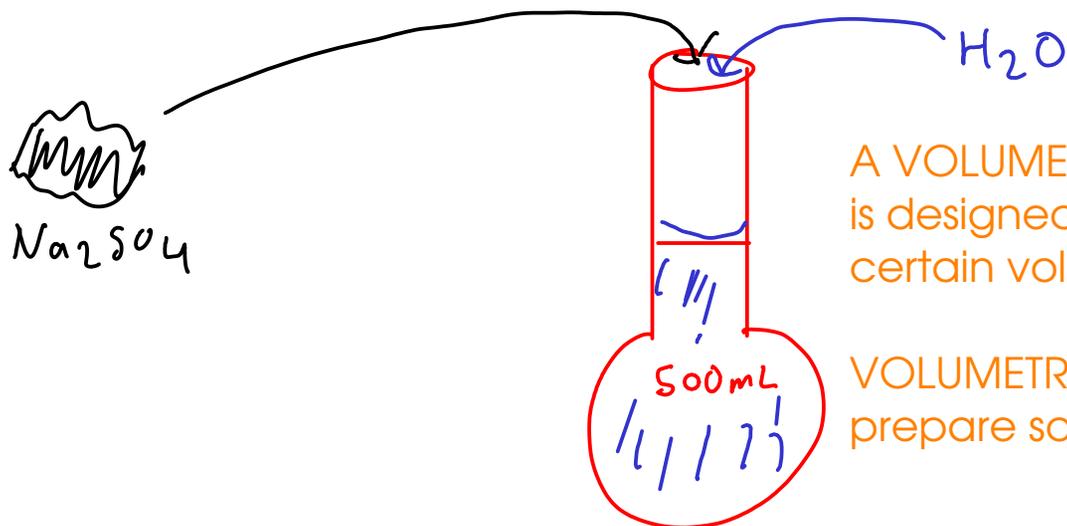


... we use MOLARITY so much because it's easy to work with. It is easier to measure the VOLUME of a liquid solution than it is to measure mass.



Example: How would we prepare 500. mL of 0.500 M sodium sulfate in water?

Dissolve the appropriate amount of sodium sulfate into enough water to make 500. mL of solution.



A VOLUMETRIC FLASK is a flask that is designed to precisely contain a certain volume of liquid.

VOLUMETRIC FLASKS are used to prepare solutions.

$$* 500 \text{ mL} = 0.500 \text{ L}$$

volumetric flask

Find the moles sodium sulfate required by using the volume and molar concentration. Then change the moles sodium sulfate to mass.

$$0.500 \text{ mol Na}_2\text{SO}_4 = \text{L} \mid \text{mL} = 10^{-3} \text{ L} \mid 142.05 \text{ g Na}_2\text{SO}_4 = \text{mol Na}_2\text{SO}_4$$

$$500. \text{ mL} \times \frac{10^{-3} \text{ L}}{\text{mL}} \times \frac{0.500 \text{ mol Na}_2\text{SO}_4}{\text{L}} \times \frac{142.05 \text{ g Na}_2\text{SO}_4}{\text{mol Na}_2\text{SO}_4} = \boxed{35.5 \text{ g Na}_2\text{SO}_4}$$

More on MOLARITY

To prepare a solution of a given molarity, you generally have two options:

- ① Weigh out the appropriate amount of solute, then dilute to the desired volume with solvent (usually water)"
- ② Take a previously prepared solution of known concentration and DILUTE it with solvent to form a new solution

"stock solution"

- Use DILUTION EQUATION

The dilution equation is easy to derive with simple algebra.

$$M \times V$$

$$\frac{\text{mol}}{\text{L}} \times \text{L} = \text{moles solute}$$

... but when you dilute a solution, the number of moles of solute REMAINS CONSTANT. (After all, you're adding only SOLVENT)

$$M_1 V_1 = M_2 V_2$$

before diution after dilution

Since the number of moles of solute stays the same, this equality must be true!

$$M_1 V_1 = M_2 V_2 \quad \dots \text{the "DILUTION EQUATION"}$$

M_1 = molarity of concentrated solution

V_1 = volume of concentrated solution

M_2 = molarity of dilute solution

V_2 = volume of dilute solution \leftarrow (TOTAL VOLUME, NOT the volume water added!)

The volumes don't HAVE to be in liters, as long as you use the same volume UNIT for both V_1 and V_2

Example: Take the 0.500 M sodium sulfate we discussed in the previous example and dilute it to make 150. mL of 0.333 M solution. How many mL of the original solution will we need to dilute?

$$M_1 V_1 = M_2 V_2$$

$$M_1 = 0.500 \text{ M}$$

$$M_2 = 0.333 \text{ M}$$

$$V_1 = ?$$

$$V_2 = 150. \text{ mL}$$

$$(0.500 \text{ M})(V_1) = (0.333 \text{ M})(150. \text{ mL})$$

$$V_1 = \boxed{99.9 \text{ mL}}$$

Measure out 99.9 mL of the 0.500 M sodium sulfate, then add water until the total volume is 150. mL

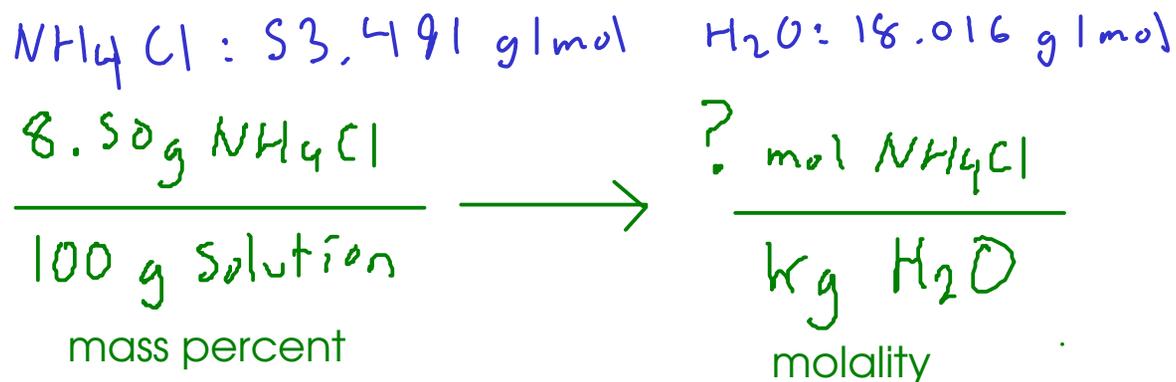
MOLARITY and the other concentration units

- To convert between molarity and the other three concentration units we've studied, you have to know more about the solution. For example:

$$\frac{\text{molarity}}{\text{moles A}} \text{ L solution} \longrightarrow \frac{\text{molality}}{\text{moles A}} \text{ kg solvent}$$

- * To perform this conversion, you can assume a liter of solution, which will give you the number of moles present. But you've then got to have a way to convert the volume of SOLUTION to the mass of the SOLVENT. How?
- * You need DENSITY (which depends on temperature). The density of the solution will allow you to find the total mass of the solution.
- * If you subtract out the mass of the SOLUTE, then what you have left is the mass of the SOLVENT. Express that in kilograms, and you have all the information you need to find molality!
- * You'll run into the same situation when you use any of the other mass or mole based units. DENSITY is required to go back and forth between MOLARITY and these units.

An aqueous solution is 8.50% ammonium chloride by mass. The density of the solution is 1.024 g/mL
Find: molality and molarity.



Assume a basis of 100g solution. this means we have 8.50 g ammonium chloride. Find mol ammonium chloride:

$$8.50 \text{ g NH}_4\text{Cl} \times \frac{\text{mol NH}_4\text{Cl}}{53.491 \text{ g NH}_4\text{Cl}} = 0.1589052364 \text{ mol NH}_4\text{Cl}$$

Find mass water:

$$100 \text{ g solution} - 8.50 \text{ g NH}_4\text{Cl} = 91.50 \text{ g H}_2\text{O} = 0.09150 \text{ kg H}_2\text{O}$$

So molality is ...

$$m = \frac{0.1589052364 \text{ mol NH}_4\text{Cl}}{0.09150 \text{ kg H}_2\text{O}} = \boxed{1.74 \text{ m NH}_4\text{Cl}}$$

