MOLAR CONCENTRATION *

- unit: MOLARITY (M): moles of dissolved substance per LITER of solution

$$M = \text{molarity} = \frac{\text{moles of SOLUTE}}{\text{L SOLUTION}}$$

dissolved substance

6.0 M HCl solution: $\frac{6.0 \text{ mol HCl}}{\text{L}}$

If you have 0.250 L (250 mL) of 6.0 M HCl, how many moles of HCl do you have?

6.0 mol HCl = L

$$0.250 \text{ L} \times \frac{6.0 \text{ mol HCl}}{\text{L}} = \boxed{1.5 \text{ mol HCl}}$$

*See SECTIONS 4.7 - 4.10 for more information about MOLARITY and solution calculations (p 154 - 162, 9th edition) (p 156 - 164, 10th edition)

If you need 0.657 moles of hydrochloric acid, how many liters of 0.0555 M HCl do you need to measure out?

$$\frac{0.0555 \text{ mol HCl}}{} = \text{L}$$

$$0.657 \text{ mol HCl} \times \frac{\text{L}}{0.0555 \text{ mol HCl}} = \boxed{11.8 \text{ L}}$$

11,800 mL

Thisi volume is much too large for lab-scale work.

You shpuld use a more concentrated solution for this application.

What if we used 6.00 M HCl?

$$6.00 \text{ mol HCl} = \text{L}$$

$$0.657 \text{ mol HCl} \times \frac{\text{L}}{6.00 \text{ mol HCl}} = \boxed{0.110 \text{ L}}$$

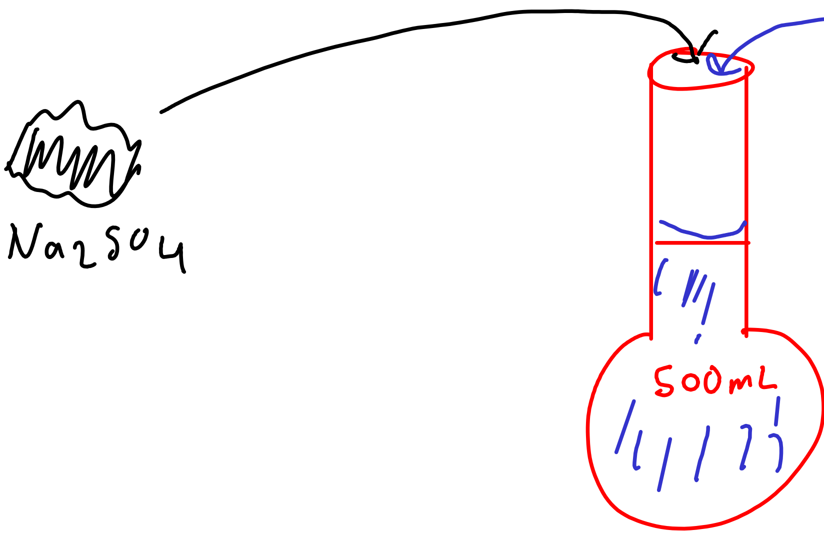
110 mL

110 mL is a volume thats easy to measure with our lan equipment! (250 mL cylinder)

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

Na_2SO_4 : 142.05 g/mol

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



volumetric flask

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

VOLUMETRIC FLASKS are used to prepare solutions.

We know that we need 500. mL of solution, and we also know that the concentration should be 0.500 M. From that, we can calculate the moles of sodium sulfate we should dissolve. Then, we can convert that to mass using formula weight.

0.500 mol Na_2SO_4 = L | mL = 10^{-3} L | 142.05 g Na_2SO_4 = mol Na_2SO_4

$$500.\,\text{mL} \times \frac{10^{-3}\,\text{L}}{\text{mL}} \times \frac{0.500\,\text{mol}\ Na_2SO_4}{\text{L}} \times \frac{142.05\,\text{g}\ Na_2SO_4}{\text{mol}\ Na_2SO_4} = \boxed{35.5\,\text{g}\ Na_2SO_4}$$

So, to prepare the solution we weigh out 35.5 grams of sodium sulfate, put that into the 500 mL flask, and fill to the mark with distilled/deionized water.

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)

"stock solution"

2. Take a previously prepared solution of known concentration and DILUTE it with solvent to form a new solution

- Use DILUTION EQUATION

The dilution equation is easy to derive with simple algebra.

$$M \times V$$

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

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

$$M_1V_1 = M_2V_2$$

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

before diution

after dilution

$$M_1V_1 = M_2V_2$$ ... 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 (total volume, not volume of added solvent!)

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

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?

$$M_1V_1 = M_2V_2$$

$$(0.500\,M)(V_1) = (0.333\,M)(150.\,mL)$$

$$V_1 = 99.9\,mL \text{ of } 0.500\,M\ Na_2SO_4$$

To prepare the solution, measure out 99.9 mL of the 0.500 M solution, add enough water to increase the volume to 150 mL. (Ideally, add the 99.9 mL of stock solution to a 150 mL volumetric flask and fill the rest of the way with distilled water!)