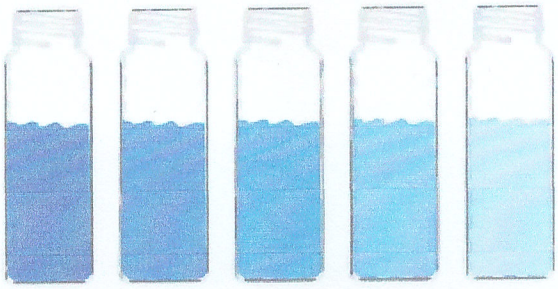
Dilutions

- Not all solutions are available in the concentrations we want/need
- A less concentrated solution can be made from a solution of known concentration by diluting it
  - **Dilution** occurs when the concentration of a solution is decreased by adding more solvent.
  - The intensity of colour can be used to compare the concertation of solutions. The more intense the colour, the more concentrated the solution.

more concentrated



more dilute

- The formula used to explain how the initial concentration and volume of a solution compares to the final concentration and volume of a diluted solution is shown below.

$$C_1V_1 = C_2V_2$$

* memorize! *

where

v_i = initial volume in consistent units

c_i = initial concentration in mol/L

v_f = final volume in consistent units

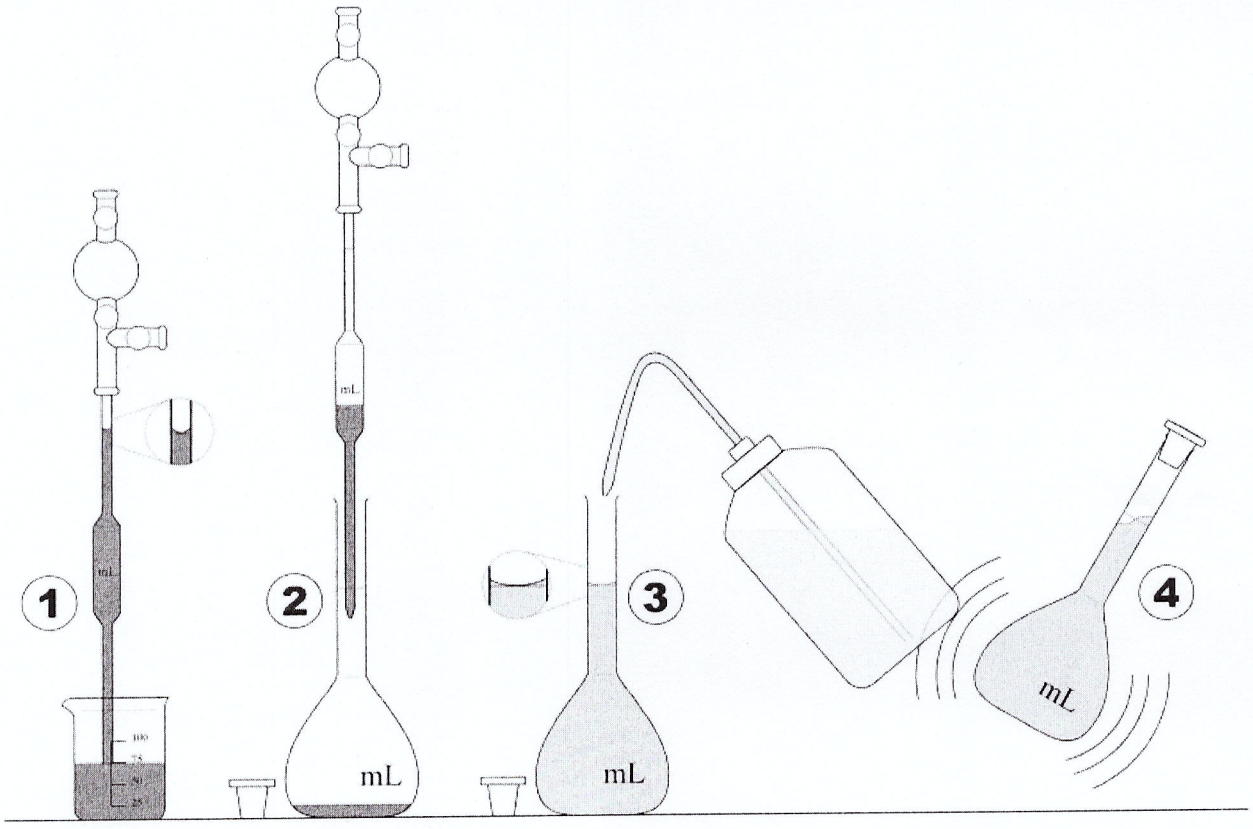
c_f = final concentration in mol/L

as long as the units are the same!

  - The number of moles of solute is not indicated in this formula because the initial number of moles should be equal the final number of moles; no
* solute is added or removed from the solution during a dilution

$$n_i = n_f$$

- To prepare a dilute solution of known concentration from a standard solution, we follow the steps outlined below.
    1. Calculate the volume of the standard solution that must be diluted to obtain a specific volume at a certain concentration.
    2. Transfer the approximate required amount of standard solution to an appropriate sized clean beaker.
    3. Rinse a pipette or a volumetric pipette with a small amount of standard solution. Discard the rinse solution to the waste container.
    4. Transfer the volume of the standard solution calculated in step 1 using either the pipette or volumetric pipette to a clean volumetric flask.
    5. Fill the volumetric flask with distilled water so that the bottom of the meniscus is at the fill line.
    6. Stopper and invert the flask several times to mix.



EXAMPLES:

1. Suppose you are given a 1.25mol/L standard aqueous solution of sodium chloride, $NaCl_{(aq)}$. What volume of standard solution must you use to prepare 200mL of 0.800mol/L $NaCl_{(aq)}$?

$C_1 = 1.25 mol/L$

$V_1 = ?$

$V_2 = 200mL$

$C_2 = 0.800 mol/L$

$C_1V_1 = C_2V_2$

$V_1 = \frac{C_2V_2}{C_1}$

$V_1 = \frac{(0.800 mol/L)(200mL)}{(1.25 mol/L)}$

$\boxed{V_1 = 128mL}$

2. A solution is prepared by adding 600mL of distilled water to 100mL of 0.15mol/L ammonium nitrate. Calculate the molar concentration of the solution.

$V_1 = 100mL$

$C_1 = 0.15 mol/L$

$C_2 = ?$

$V_2 = 700mL$

$C_1V_1 = C_2V_2$

$\frac{C_1V_1}{V_2} = C_2$

$C_2 = \frac{(0.15 mol/L)(100mL)}{700mL}$

$C_2 = 0.0214285... mol/L$

$\boxed{C_2 = 0.021 mol/L}$

Now try Practice Problems #1-5

Practice Problems

1. What concentration of solution is obtained by diluting 50.0mL of 0.720mol/L aqueous sodium nitrate, $NaNO3_{(aq)}$, to 400mL? **[0.0900 mol/L]**

2. Calculate the volume of solution required to prepare 1.50L of 0.00350 mol/L copper(II) sulphate, $CuSO4_{(aq)}$, from a 1.25 mol/L standard. **[4.20 mL]**

3. What is the concentration of a 1.50L solution if it is made by mixing 500mL of 14.8mol/L $H_2SO4_{(aq)}$ with 1.00L of water? **[4.93 mol/L]**

4. What volume of 1.25mol/L sodium chloride solution do you need to make 250mL of 0.550mol/L sodium chloride solution? **[110 mL]**

5. A student made the following errors while preparing solutions. Describe how the errors will affect the resulting solution; will it be more concentrated or more dilute than expected? Explain what the student should have done.
    a. Before using a pipette to draw up the standard solution, the student rinses the pipette with distilled water but not with standard solution.

    b. The student uses the pipette bulb to force out the final drop of solution from the pipette.

Answers:

5.

a. The solution will be more dilute than expected because some of the water remained in the pipette, which meant that not enough standard solution was drawn up into the pipette. The student should have only rinsed the pipette with standard solution first, not water.
b. The solution will be more concentrated than expected because the pipettes are calibrated to deliver the final volume just by draining on their own and not forcing out the small volume that remains in the pipette. The student should have let the pipette drain on its own and not force out the small volume in the pipette with the bulb.