pHet: Molarity

- Go to: https://phet.colorado.edu/en/simulation/molarity

Click on "Run in HTML5"

pHet: Molarity

Solute Amount (moles)
1.0

0.53 mol

0.2

0

Solution Volume (Liters)
1.0

0.50 L

Co(NO$_3$)$_2$

1 L

½ L

Solution Concentration (Molarity)
5.0

1.06 M

0

☑ Show values   Solute: ■ Cobalt (II) nitrate ▲
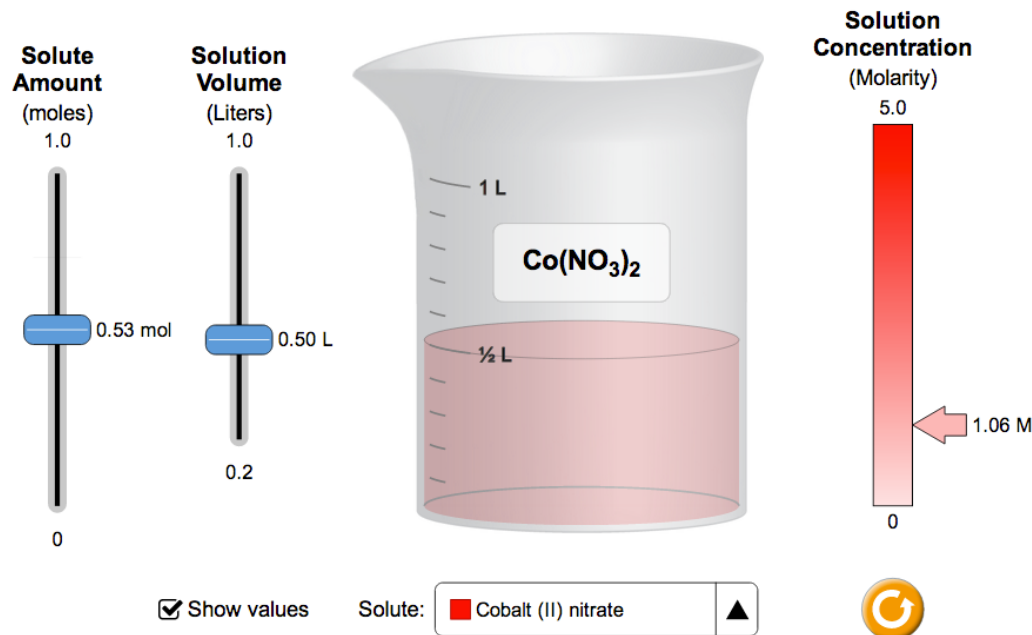
1. Adjust moles of solute while leaving volume constant. What happens to molarity when you increase moles? Decrease moles?
2. Adjust volume while leaving moles constant. What happens to molarity when volume is increased? Decreased?
3. Set sample to Co(NO$_3$)$_2$. What happens to color of liquid as molarity increases? Why?

Concentrations of Solutions

- Concentration of a solution: the more solute in a given volume of solvent, the more concentrated

- 1 tsp salt (NaCl)/cup of water

  vs

- 3 Tbsp salt/cup water

Molarity

Molarity is one way to measure the concentration of a solution.

$$\text{Molarity } (M) = \frac{\text{moles of solute}}{\text{volume of solution in liters}}$$
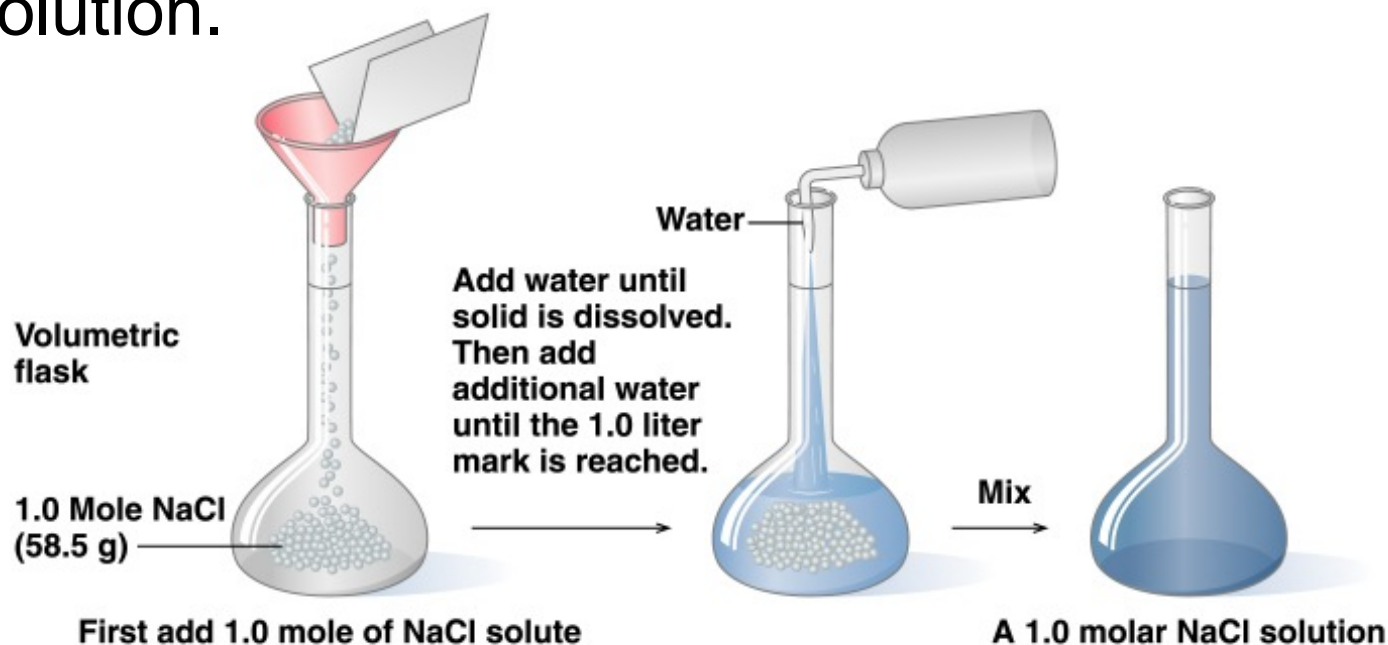
A 1.00 molar (1.00 M) solution contains 1.00 mol solute in every 1 liter of solution.

Units of molarity are: mol/L = M

Preparing a 1.0 Molar Solution

One liter of a 1.00 M NaCl solution
- need 1.00 mol of NaCl
- weigh out 58.5 g NaCl (1.00 mole) and
- add water to make 1.00 liter (total volume) of solution.

Volumetric flask

1.0 Mole NaCl (58.5 g)

Water

Add water until solid is dissolved. Then add additional water until the 1.0 liter mark is reached.

Mix

First add 1.0 mole of NaCl solute

A 1.0 molar NaCl solution

Timberlake, *General, Organic, and Biological Chemistry.* Copyright © Pearson Education Inc., publishing as Benjamin Cummings

Molarity Practice

- What is the molar NaCl concentration if you have 0.5 mol NaCl in 1.00 L of solution?

- What is the molar NaCl concentration if you have 0.5 mol NaCl in 0.50 L of solution?

Molarity Practice

What is the molar NaCl concentration if you have 10.0 g of NaCl in 1.00 L of solution?

Molarity – Moles - Volume

$$\text{Molarity } (M) = \frac{\textbf{moles of solute}}{\textbf{volume of solution in liters}}$$

$$\text{Molarity } (M) = \frac{\textbf{mol}}{\textbf{Volume (L)}}$$

- Have mol and vol → molarity
- Have molarity and vol → mol of solute
- Have molarity and mol of solute → volume
- <u>AND:</u> mol of solute → grams of solute

Practice

How many moles of HCl are present in 2.5 L of 0.10 M HCl?

Given: 2.5 L of soln

            0.10M HCl

Find: mol HCl   = 0.10 mol/1 L HCl

Practice

What volume of a 0.10 M NaOH solution is needed to provide 0.50 mol of NaOH?

Given: 0.50 mol NaOH

0.10 M NaOH = 0.10 mol NaOH / 1L

Find: **vol soln**

More Practice

How many grams of $CuSO_4$ are needed to prepare 250.0 mL of 1.00 M $CuSO_4$?

Given: 250.0 mL soln

1.00 M $CuSO_4$

Find: g $CuSO_4$

Dilutions

- Many laboratory chemicals such as acids are purchased as **concentrated** solutions (<u>stock solutions</u>).
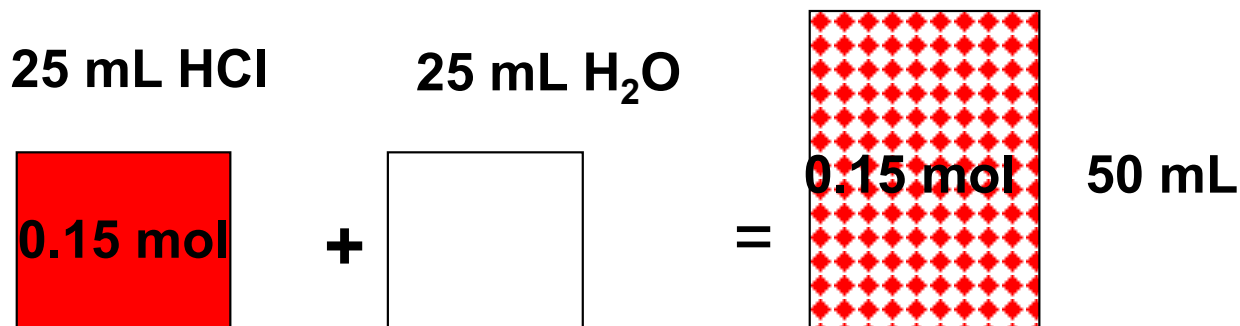
  e.g. 12 M HCl

   12 M H_2SO_4

- More dilute solutions are prepared by taking a certain quantity of the stock solution and diluting it with water.

Dilutions

- A given volume of a stock solution contains a specific number of moles of solute.

    e.g.: 25 mL of 6.0 M HCl contains 0.15 mol HCl

    (How do you know this???)

25 mL HCl　　　**25 mL H$_2$O**

0.15 mol　**+**　　　　**=**　0.15 mol　**50 mL**

- If 25 mL of 6.0 M HCl is diluted with 25 mL of water, the number of moles of HCl present does not change.

    Still contains 0.15 mol HCl

Dilutions

moles solute = moles solute

before dilution after dilution

Dilution Calculation

- When a solution is diluted, the concentration of the new solution can be found using:

$$M_1 \times V_1 = M_2 \times V_2$$

where M_1 = initial concentration (mol/L)= more

       concentrated

    V_1 = initial volume of more conc. solution

    M_1 = final concentration (mol/L) in dilution

    V_1 = final volume of diluted solution

Dilution Calculation

What is the concentration of a solution prepared by diluting 25.0 mL of 6.00 M HCl to a total volume of 50.0 mL?

Given: V_1 = 25.0 mL

M_1 = 6.00 M

V_2 = 50.0 mL

Note: V_1 and V_2 do not have to be in liters, but they must be in the same units.
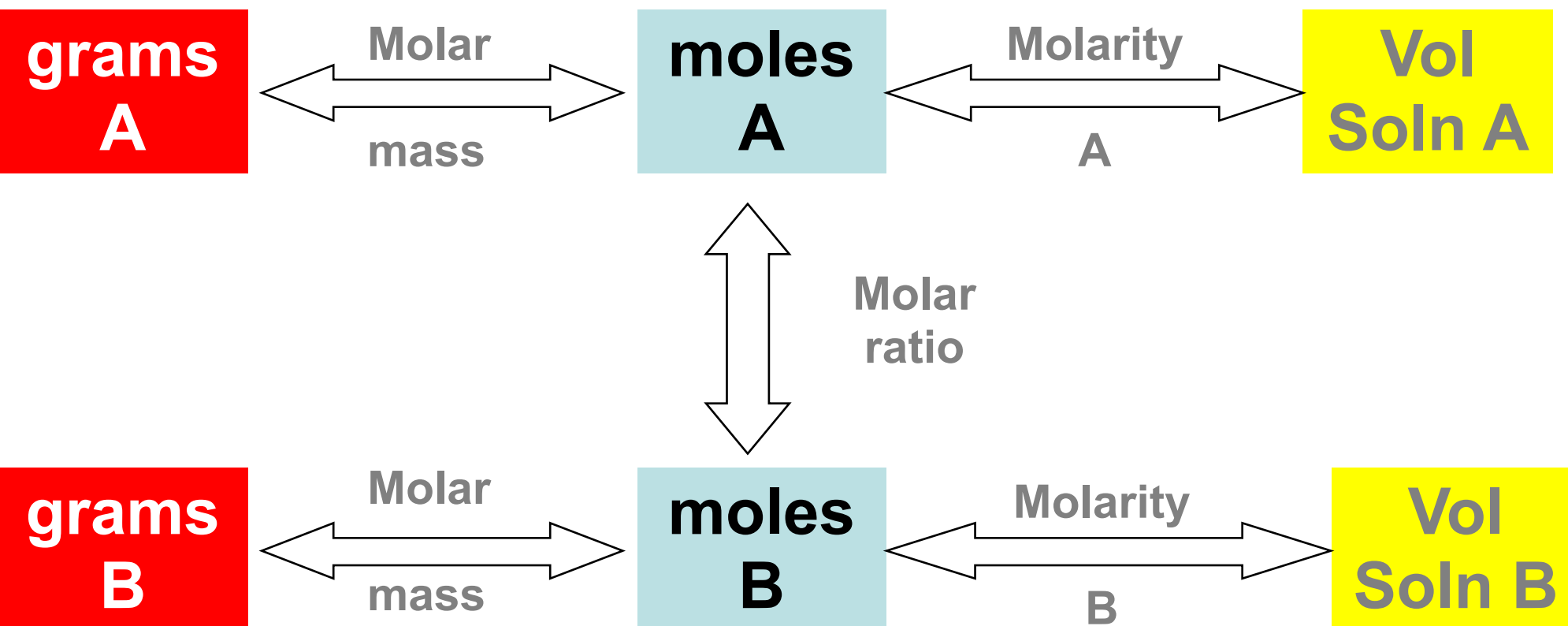
Find: M_2

Use **$V_1 \times M_1 = V_2 \times M_2$** Solve for M_2

Practice

- How many mL of 5.0 M $K_2Cr_2O_7$ solution must be diluted to prepare 250 mL of 0.10 M solution?

- If 10.0 mL of a 10.0 M stock solution of NaOH is diluted to 250 mL, what is the concentration of the resulting solution?

Solution Stoichiometry

- Remember: reactions occur on a mole to mole basis.

  - For pure reactants, we <u>measure</u> reactants using **mass**

  - For reactants that are added to a reaction as aqueous solutions, we <u>measure</u> the reactants using **volume of solution.**

Solution Stoichiometry

Solution Stoichiometry Practice

If 25.0 mL of 2.5 M NaOH are needed to neutralize (i.e. react completely with) a solution of H_3PO_4, how many moles of H_3PO_4 were present in the solution?

3NaOH (aq) + H_3PO_4 (aq) → Na$_3$PO$_4$ (aq) + 3H$_2$O(l)
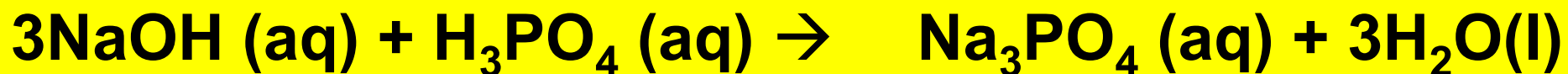
Given: 25.0 mL 2.5 M NaOH

balanced eqn: 3 mol NaOH/1 mol H_3PO_4

Find: moles of H_3PO_4