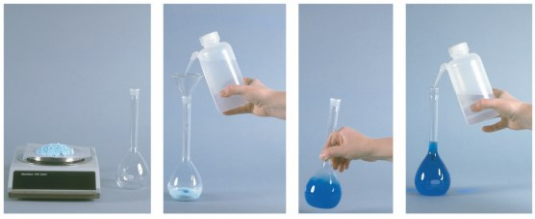
Steps involved in preparing solutions from pure solids



Steps involved in preparing solutions from pure solids

- Calculate the amount of solid required
- Weigh out the solid
- Place in an appropriate volumetric flask
- Fill flask about half full with water and mix.
- Fill to the mark with water and invert to mix.

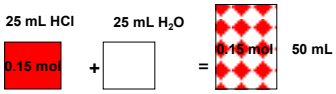
You should be able to describe this process (including calculating the mass of solid to use) for any solution I specify.

Dilutions

- Many laboratory chemicals such as acids are purchased as **concentrated** solutions (stock solutions).
  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???)



- 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 before dilution = moles solute after dilution

- Although the number of moles of solute does not change, the volume of solution does change.
- The concentration of the solution will change since

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

Dilution Calculation

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

$$M_c \times V_c = M_d \times V_d$$

where M_c= initial concentration (mol/L)= more concentrated

V_c = initial volume of more conc. solution

M_d =final concentration (mol/L) in dilution

V_d = 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_c = 25.0 mL
M_c = 6.00 M
V_d = 50.0 mL

Note: V_c and V_d do not have to be in liters, but they must be in the same units.

Find: M_d

Use **$V_c x M_c = V_d x M_d$** Solve for M_d

Dilution

- Make a diluted solution once you know V_c and V_d
  - Use a pipet to deliver a volume of the concentrated solution to a new volumetric flask.
  - Add solvent to the line on the neck of the new flask.
  - Mix well.

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?

  V_c = ? M_c = 5.0M V_d = 250 mL M_d = 0.10M

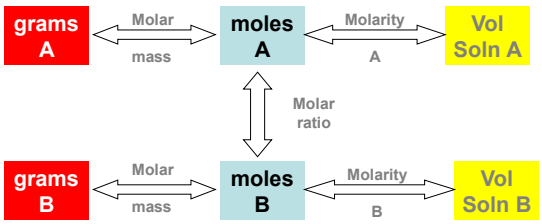
- If 10.0 mL of a 10.0 M stock solution of NaOH is diluted to 250 mL, what is the concentration of the resulting solution?

  M_d = ? V_c = 10.0 mL M_c = 10.0M V_d = 250 mL

Solution Stoichiometry

- Remember: reactions occur on a mole to mole basis.
  - For pure reactants, we measure reactants using **mass**
  - For reactants that are added to a reaction as aqueous solutions, we measure 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?

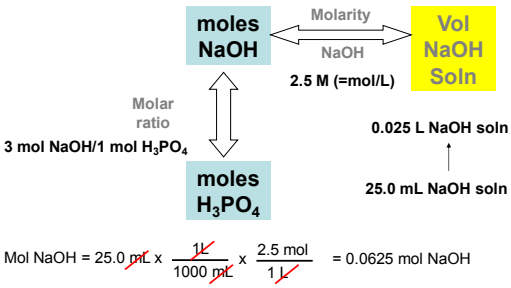
$3NaOH\ (aq) + H_3PO_4\ (aq) \rightarrow Na_3PO_4\ (aq) + 3H_2O(l)$

Given: 25.0 mL 2.5 M NaOH

balanced eqn: 3 mol NaOH/1 mol H_3PO_4

Find: moles of H_3PO_4

Approach



Mol NaOH = 25.0 ~~mL~~ x $\frac{1\ \cancel{L}}{1000\ \cancel{mL}}$ x $\frac{2.5\ mol}{1\ \cancel{L}}$ = 0.0625 mol NaOH

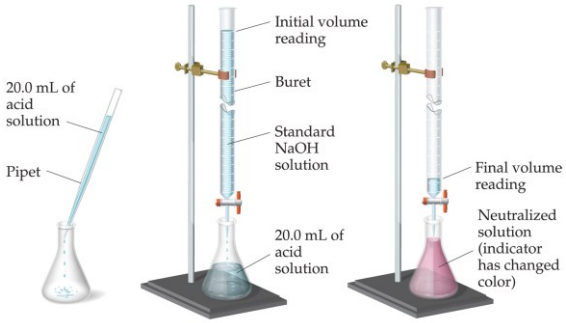
More practice

What mass of aluminum hydroxide is needed to neutralize 12.5 mL of 0.50 M sulfuric acid?

Solution Stoichiometry

- Solution stoichiometry can be used to determine the concentration of aqueous solutions used in reactions.
- Concentration of an acid can be determined using a process called titration.
  reacting a known volume of the acid with a known volume of a standard base solution (i.e. a base whose concentration is known)

Titration



Practice

If 35.50 mL of 2.5 M NaOH are needed to neutralize 50.0 mL of an H_3PO_4 solution, what is the concentration (molarity) of the H_3PO_4 solution?

$3NaOH\ (aq) + H_3PO_4\ (aq) \rightarrow Na_3PO_4\ (aq) + 3H_2O(l)$

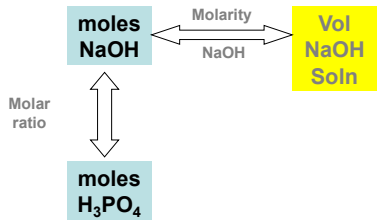
Given: 35.50 mL 2.5 M NaOH
50.0 mL of H_3PO_4 sol'n

Find: molarity (mol/L) H_3PO_4

Strategy: $M = \frac{\text{moles}}{L}$

- To find the concentration of H_3PO_4 soln, we need both # moles and volume of H_3PO_4.
- Since volume is given, we can simply find moles and plug into the equation for M.

Plan



Mol H_3PO_4 = 35.5 mL x $\frac{1\ L}{1000\ mL}$

x $\frac{2.50\ mol\ NaOH}{1\ L}$ x $\frac{1\ mol\ H_3PO_4}{3\ mol\ NaOH}$

= 0.0296 mol H_3PO_4

We're not done….we need molarity.

Molarity of H_3PO_4

Molarity = $\frac{moles}{L}$

= $\frac{0.0296\ mol\ H_3PO_4}{50.0\ mL}$ x $\frac{1000\ mL}{L}$

= 0.592 M H_3PO_4