PERCENTAGE COMPOSITION

- sometimes called "percent composition" or "percent composition by mass"
- the percentage of each element in a compound, expressed in terms of mass

Example: Find the percentage composition of ammonium nitrate.

NH_4^+ NO_3^-

NH_4NO_3:

N : 2 x 14.01 = 28.02
H : 4 x 1.008 = 4.032
O : 3 x 16.00 = 48.00

80.052 g NH_4NO_3 = 1 mol NH_4NO_3

$$\%N = \frac{28.02\text{ g N}}{80.052\text{ g total}} \times 100\% = 35.0\%\ N$$

$$\%H = \frac{4.032\text{ g H}}{80.052\text{ g total}} \times 100\% = 5.0\%\ H$$

$$\%O = \frac{48.00\text{ g O}}{80.052\text{ g total}} \times 100\% = 60.0\%\ O$$

100%

These percentages should sum to 100% (at least, within rounding errors)

So far, we have

ch8

- looked at how to determine the composition by mass of a compound from a formula
- converted from MASS to MOLES (related to the number of atoms/molecules)
- converted from MOLES to MASS

Are we missing anything?

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- What about SOLUTIONS, where the desired chemical is not PURE, but found DISSOLVED IN WATER?
- How do we deal with finding the moles of a desired chemical when it's in solution?

MOLAR CONCENTRATION

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

$$M = \text{MOLARITY} = \frac{\text{moles of solute}}{\text{L solution}}$$

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

There are 6.0 moles of hydrochloric acid in each liter of this solution, so you can write this relationship another way:

$$6.0 \text{ mol HCl} = 1 \text{ L}$$

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

$$0.250 \text{ L} \times \frac{6.0 \text{ mol HCl}}{1 \text{ L}} = 1.5 \text{ mol HCl}$$

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

$$0.0555 \text{ mol HCl} = 1 \text{ L}$$

$$0.657 \text{ mol HCl} \times \frac{1 \text{ L}}{0.0555 \text{ mol HCl}} = \boxed{\begin{array}{c} 11.8 \text{ L} \\ (11{,}800 \text{ mL}) \end{array}}$$

... too large a volume for lab-scale work!

What if we used 6.00 M HCl?

$$6.00 \text{ mol HCl} = 1 \text{ L}$$

$$0.657 \text{ mol HCl} \times \frac{1 \text{ L}}{6.00 \text{ mol HCl}} = \boxed{\begin{array}{c} 0.110 \text{ L} \\ (110. \text{ mL}) \end{array}}$$

... a reasonable volume for something in the lab!

If you're preparing a solution by dissolving a solid in water, you can easily calculate the molaroity of the solution. How?

Just find the number of moles of solid you dissolved, then divide by the volume of the solution (expressed in liters!)

What is the molarity of a solution made by dissolving 3.50 g of NaCl in enough water to make 250. mL of solution?

$$M = \frac{\text{moles NaCl}}{\text{L solution}}$$

Find moles of NaCl:

Na : 1 x 22.99

Cl : 1x 35.45

58.44 g NaCl = 1 mol NaCl

$$3.50 \text{ g NaCl} \times \frac{1 \text{ mol NaCl}}{58.44 \text{ g NaCl}} = 0.05989 \text{ mol NaCl}$$

Find L of solution:

$$\text{mL} = 10^{-3} \text{ L}$$

$$250. \text{ mL} \times \frac{10^{-3} \text{ L}}{\text{mL}} = 0.250 \text{ L}$$

$$M = \frac{0.05989 \text{ mol NaCl}}{0.250 \text{ L}} = \boxed{0.240 \text{ } \underline{M} \text{ NaCl}}$$

A few more examples...

You have a 250.g bottle of silver(I) chloride (AgCl). How many moles of AgCl do you have?

$AgCl: \quad Ag: 1 \times 107.9$

$\quad\quad\quad\quad Cl: 1 \times 35.45$

$\quad\quad\quad\quad\quad 143.35\ g\ AgCl = 1\ mol\ AgCl$

$$250\ g\ AgCl \times \frac{1\ mol\ AgCl}{143.35\ g\ AgCl} = \boxed{1.74\ mol\ AgCl}$$

How many moles of NaOH are present in 155 mL of 1.50 M NaOH?

$1.50\ mol\ NaOH = 1\ L \quad\quad mL = 10^{-3}\ L$

$$155\ mL \times \frac{10^{-3}\ L}{mL} \times \frac{1.50\ mol\ NaOH}{1\ L} = \boxed{0.233\ mol\ NaOH}$$