# Math Tutor CALCULATING PERCENTAGE COMPOSITION

Chemists can analyze an unknown substance by determining its percentage composition by mass. Percentage composition is determined by finding the mass of each element in a sample of the substance as a percentage of the mass of the whole sample. The results of this analysis can then be compared with the percentage composition of known compounds to determine the probable identity of the unknown substance. Once you know a compound's formula, you can determine its percentage composition by mass.

## SAMPLE 1

**Determine the percentage composition of potassium chlorate, $KClO_3$.**

First, calculate the molar mass of $KClO_3$. The formula shows you that one mole of $KClO_3$ consists of 1 mol K atoms, 1 mol Cl atoms, and 3 mol O atoms. Thus, the molar mass of $KClO_3$ is molar mass K + molar mass Cl + 3(molar mass O) = 39.10 g K + 35.45 g Cl + 3(16.00 g O).

$$\text{molar mass } KClO_3 = 122.55 \text{ g}$$

The percentage composition of $KClO_3$ is determined by calculating the percentage of the total molar mass contributed by each element.

$$\frac{\text{mass of element in 1 mol of compound}}{\text{molar mass of compound}} \times 100 = \% \text{ element in compound}$$

$$\% \text{ K in } KClO_3 = \frac{39.10 \text{ g K}}{122.55 \text{ g } KClO_3} \times 100 = 31.91\%$$

$$\% \text{ Cl in } KClO_3 = \frac{35.45 \text{ g Cl}}{122.55 \text{ g } KClO_3} \times 100 = 28.93\%$$

$$\% \text{ O in } KClO_3 = \frac{48.00 \text{ g O}}{122.55 \text{ g } KClO_3} \times 100 = 39.17\%$$

## SAMPLE 2

**Determine the percentage of nitrogen in ammonium sulfate, $(NH_4)_2SO_4$.**

Even though you want to find the percentage of only one element, you must calculate the molar mass of $(NH_4)_2SO_4$. To do that, examine the formula to find the number of moles of each element in the compound. The two ammonium groups, indicated by $(NH_4)_2$, contain 2 mol N and 8 mol H per mole of $(NH_4)_2SO_4$. The sulfate group, $SO_4$, contains 1 mol S and 4 mol O per mole of $(NH_4)_2SO_4$.

| | |
|---|---|
| 2 mol N = 2 × 14.01 g = | 28.02 g |
| 8 mol H = 8 × 1.01 g = | 8.08 g |
| 1 mol S = 1 × 32.07 = | 32.07 g |
| 4 mol O = 4 × 16.00 = | 64.00 g |
| molar mass $(NH_4)_2SO_4$ = | 132.17 g |

Now, you can determine the percentage of nitrogen in the compound as follows.

$$\% \text{ N in } (NH_4)_2SO_4 = \frac{28.02 \text{ g N}}{132.17 \text{ g } (NH_4)_2SO_4} \times 100 = 21.20\%$$

## PRACTICE PROBLEMS

1. What is the percentage composition of sodium carbonate, $Na_2CO_3$?
2. What is the percentage of iodine in zinc iodate, $Zn(IO_3)_2$?