# Formulas from Masses

The molecular formula for a compound can be determined from the percentage composition by assuming the sample has a mass of 100 g. Using the percentages, the number of grams out of 100 can be determined for each component. This can be converted to moles by dividing by the GFM. The mole ratio and empirical formula can be determined by dividing each number of moles by the smallest number of moles. The atomic masses are added together to find the empirical formula mass. The empirical formula mass is divided into the molecular weight to find the number of times "n," the formula is repeated. Finally, "n" is multiplied by the empirical formula to find the molecular formula. See the ***Sample Problem*** to the right.

**Sample Problem**

**Find the molecular formula for a compound composed of 5.9% hydrogen and 94.1% oxygen and having a molecular weight of 34 amu.**

**Step 1**: Assume a 100 g sample

**Step 2**: Find the mass of each element in the sample

mass of H = 5.9 % of 100 g = 5.9 g
mass of O = 94.1 % of 100 g = 94.1 g

**Step 3**: Convert grams to moles

moles of H = $\frac{5.9g}{1g/mol}$ = 5.9 moles

moles of O = $\frac{94.1g}{16g/mol}$ = 5.9 moles

**Step 4**: Find the mole ratio by dividing both numbers by the smaller number

5.9 ÷ 5.9 = 1 H
5.9 ÷ 5.9 = 1 O
**empirical formula =** HO

**Step 5**: Find the empirical formula mass

atomic mass of H = 1
atomic mass of O = 16
EFM = 17

**Step 6**: Find the number of times, "n," the empirical formula is repeated and multiply through

$\frac{M.W.}{EFM} = n = \frac{34}{17} = 2$

**molecular formula** $(HO)_n = (HO)_2 = H_2O_2$

**Answer the questions below.**

**1.** What is the percentage composition of each of the elements in the following compounds?

a) NaOH

b) $KHCO_3$

c) $(NH_4)_2SO_4$

d) $CuSO_4$

**2.** Calculate the percentage of water in each of the following hydrates.

a) $CaC1_2 \cdot 10H_2O$

b) $CaSO_4 \cdot 6H_2O$

**3.** A strip if copper weighing 6.4 grams is heated in a stream of oxygen until it is converted to an oxide. The mass of the oxide is 8.0 g.

a) What is the percentage composition of this compound?

b) Is the formula of this compound CuO or is it $Cu_2O$ ?(show work)

**4.** Find the empirical formula for the following compounds(use the percentage composition given for each).
a) Na = 43.4 %; C = 11.3 %; O = 45.3 %

b) Cu = 34.0 %; N = 14.9 %; O = 51.1 %

c) Al = 18.4 %; S = 32.7 %; O = 48.9 %

**5.** Find the molecular formula of each of the following compounds.
a) C = 82.8 %; H = 17.2 %; M.W. = 58

b) H = 5.9 %; O = 94.1 %; M.W. = 34

c) C = 93.75 %; H = 6.25 %; M.W. = 128