FORMULAS FROM MASSES

Percent Composition

EMPIRICAL FORMULAS

- Answer the following questions about $CuSO_4$:
  - What is the empirical formula? **$CuSO_4$**
  - What is the mole ratio of the elements? **1:1:4**
  - What is the percentage composition? **Cu=40%; S=20%; O=40%**
- How many moles are each of the following:
  - 40.0 g of Cu? **0.625 mol**
  - 20.0 g of S? **0.625 mol**
  - 40.0 g of O? **2.5 mol**
- What is the mole ratio of 40.0 g of Cu to 20.0 g of S to 40.0 g of O? **1:1:4**
- So, how do you determine the chemical formula from the percentage composition?

EMPIRICAL FORMULAS FROM PERCENTAGES

Find the empirical formula for a compound composed of 5.9% hydrogen and 94.1% oxygen

- **Step 1:** Assume you have 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 = $(5.9\text{ g})\left(\frac{1\text{ mol H}}{1\text{ g H}}\right)$ = 5.9 moles
  - moles of O = $(94.1\text{ g})\left(\frac{1\text{ mol O}}{16\text{ g O}}\right)$ = 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**

MOLECULAR FORMULAS FROM EMPIRICAL FORMULAS

Find the molecular formula for a compound with an empirical formula of HO and a molecular weight of 34 amu.

- **Step 1:** Find the empirical formula mass.
  - atomic mass of H = 1
  - atomic mass of O = 16
  - EFM = 17
- **Step 2:** Find the number of times (n) the empirical formula is repeated by dividing the molecular weight by the empirical formula mass.
  - $\frac{\text{M.W.}}{\text{EFM}} = n = \frac{34 \text{ amu}}{17 \text{ amu}} = 2$
- **Step 3:** Find the molecular formula by multiplying the empirical formula by "n."
  - $(HO)_n = (HO)_2 = \mathbf{H_2O_2}$