

### 3. Finding Molecular Formula

Remember a molecular formula shows the actual number of atoms of each element in a compound. It may or may not be the lowest whole number ratio. In order for us to determine the molecular formula, we need to know the percentage composition and the molar mass.

- Assume one mole of the substance, and multiply by the percentage composition for each element to change it into grams
- Next convert each mass to moles by using  $n = \frac{m}{M}$
- Round off each number of moles to a whole number and use those values as the subscripts in the formula

Example: An unknown substance was found to be 85.60% carbon and 14.40 % hydrogen. If the molar mass of the unknown substance was determined to be 28.06 g/mol, determine the molecular formula.

Find the mass by using the molar mass and the percentages given:

$$\text{m of carbon} = 28.06 \text{ g} \times 85.60 \% = 24.02 \text{ g}$$

$$\text{m of hydrogen} = 28.06 \text{ g} \times 14.40 \% = 4.041 \text{ g}$$

Next convert the mass of each element to moles:

$$n \text{ of carbon} = \frac{m}{M} = \frac{24.02 \text{ g}}{12.01 \text{ g/mol}} = 2.000 \text{ mol}$$

$$n \text{ of hydrogen} = \frac{m}{M} = \frac{4.041 \text{ g}}{1.01 \text{ g/mol}} = 4.00 \text{ mol}$$

Change the numbers of moles to subscripts:

Answer:  $\text{C}_2\text{H}_4$

Now try these:

1. Determine the molecular formula of a compound that is 92.24 % carbon and 7.76 % hydrogen. The compound has a molar mass of 78.12 g/mol.
2. Determine the molecular formula of a compound that is 87.40 % nitrogen and 12.60 % hydrogen. The compound has a molar mass of 32.06 g/mol.
3. Determine the molecular formula of a compound that is 94.06 % oxygen and 5.94 % hydrogen. The compound has a molar mass of 34.02 g/mol.