PRACTICE PROBLEMS:

1. The empirical formula for a common drying agent is P_2O_5. The molecule has a molar mass of 283.88 g/mol. Find the molecular formula of the compound.

Answers:

- ***When determining Molecular Formulas, you must first determine the Empirical formula. In this problem, the Empirical formula is given.***

- ***Since you are given the Empirical formula, we can determine the Molecular formula by using the following equation:***

$$n = \frac{Molecular Formula\ mass\ \ (given in the problem)}{Empirical Formula\ mass\ \ (you\ must\ calculate)}$$

- ***Therefore, we must first determine the Empirical formula mass for P_2O_5:***

$$P_2O_5 = (2)(30.97\ g/mol) + (5)(16.00\ g/mol) = 141.94\ g/mol$$

- ***Let's now insert the values into the equation and solve for "n":***

$$n = \frac{Molecular Formula\ mass}{Empirical Formula\ mass} = \frac{283.88\ \frac{g}{mol}}{141.94\ \frac{g}{mol}} = 2$$

- ***I guess now would be a good time to discuss the significance of "n"… "n" represents the multiplier that we must use to determine the molecular formula. Recall, Empirical formula represents the "smallest-whole-number ratio" of elements within a compound. Molecular formula represents the "actual" number of elements within a compound (that is not an ionic compound – therefore, molecular (hence the name)). So…***

$$(P_2O_5)_n \quad ; \ where \quad n = 2$$

$$(P_2O_5)_2 = P_4O_{10}$$

- ***Since we calculated "n" to equal 2, then the Empirical formula is multiplied by a factor of two to determine the molecular formula for the compound.***

Empirical Formula = smallest whole number ratio

Molecular Formula = the actual formula for the compound

Yes, in some cases - the compounds have the same formula for empirical and molecular…

2. Hydrazine is a widely used compound. It can be used to treat waste water from chemical plants removing ions that may be hazardous to the environment; it can be used in rocket fuels; and it can help prevent corrosion in the pipes of electric plants. In a 32.0 gram sample of hydrazine, there are 28.0 grams of nitrogen and 4.0 grams of hydrogen. The molar mass of the molecule is 32.0 g/mol. What is the empirical and molecular formula for hydrazine?

Answers:

- ***Wow, what a great question… Half of the question (first half) has nothing to do with solving the problem…***

- ***Since the question is asking for both Empirical and Molecular – start with determining the Empirical formula…***

- ***Convert the grams to moles:***

$$\frac{28.0\ g\ N}{} \times \frac{1\ mole\ N}{14.01\ g} = 1.99857\ mol\ N$$

$$\frac{4.0\ g\ H}{} \times \frac{1\ mole\ H}{1.008\ g} = 3.9683\ mol\ H$$

- ***Determine the mole ratio:***

N: $\frac{1.99857\ mol}{1.99857\ mol} = 1.00$

H: $\frac{3.9683\ mol}{1.99857\ mol} = 1.99 = 2.00$

The ratio is:

1 : 2

Empirical Formula:

NH_2

- ***Determine the molecular formula:***

Empirical Formula mass = NH_2 = (14.01 g/mol) + (2) (1.008 g/mol) = 16.026 g/mol

$$n = \frac{Molecular Formula\ mass}{Empirical Formula\ mass} = \frac{32.00\ \frac{g}{mol}}{16.026\ \frac{g}{mol}} = 2$$

$(NH_2)_n$; where n = 2

$(NH_2)_2 = N_2H_4$