

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:*

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

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

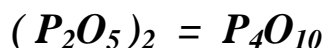
$$P_2O_5 = (2)(30.97 \text{ g/mol}) + (5)(16.00 \text{ g/mol}) = 141.94 \text{ g/mol}$$

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

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

- *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...*

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



- *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:*

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

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

- *Determine the mole ratio:*

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

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

The ratio is:

1 : 2

Empirical Formula:

NH₂

- *Determine the molecular formula:*

$$\text{Empirical Formula mass} = \text{NH}_2 = (14.01 \text{ g/mol}) + (2)(1.008 \text{ g/mol}) = 16.026 \text{ g/mol}$$

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

$(\text{NH}_2)_n$; where $n = 2$

