

Finding Empirical and Molecular Formulas

Problem:

A compound is 75.46% carbon, 4.43% hydrogen, and 20.10% oxygen by mass. It has a molecular weight of 318.31 g/mol. What is the molecular formula for this compound?

Strategy:

1. Find the empirical formula

- Get the mass of each element by assuming a certain overall mass for the sample (100 g is a good mass to assume when working with percentages).

$$(.7546) (100 \text{ g}) = 75.46 \text{ g C}$$

$$(.0443) (100 \text{ g}) = 4.43 \text{ g H}$$

$$(.2010) (100 \text{ g}) = 20.10 \text{ g O}$$

- Convert the mass of each element to moles using molar mass of the element.

$$(75.46 \text{ g C}) (1 \text{ mol} / 12.00 \text{ g C}) = 6.289 \text{ mol C}$$

$$(4.43 \text{ g H}) (1 \text{ mol} / 1.008 \text{ g H}) = 4.39 \text{ mol H}$$

$$(20.10 \text{ g O}) (1 \text{ mol} / 16.00 \text{ g O}) = 1.256 \text{ mol O}$$

- Find the ratio of the moles of each element.

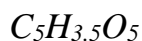
Divide by the smallest mole value found in the previous step.

$$(1.256 \text{ mol O}) / (1.256) = 1 \text{ mol O}$$

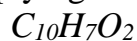
$$(6.289 \text{ mol C}) / (1.256) = 5.007 \text{ mol C}$$

$$(4.39 \text{ mol H}) / (1.256) = 3.50 \text{ mol H}$$

- Use the mole values found in the previous step as subscripts to write the empirical formula.



- Multiplying the mole ratios by two to get whole number, the empirical formula becomes:



2. Find the molar mass of the empirical formula.

$$10(12.00) + 7(1.008) + 2(16.00) = 159.06 \text{ g/mol}$$

3. Figure out how many empirical units are in a molecular unit.

$$(318.31 \text{ g/mol}) / (159.06 \text{ g/mol}) = 2.001 \text{ empirical units per molecular unit}$$

4. Write the molecular formula.

Since there are two empirical units in a molecular unit, the molecular formula is:

