

Answer on Question #43515 - Chemistry - Organic Chemistry

Question:

The percentage composition of acetaldehyde is 54.5% C, 9.2% H, and 36.3% O, and its molecular mass is 44 amu. Obtain the molecular formula of acetaldehyde.

Answer:

Change each percentage to an expression of the mass of each element in grams. That is 54.5% C becomes 54.5 g C, 9.2% H becomes 9.2 g H, and 36.3% O becomes 36.3 g O.

Convert the amount of each element in grams to its amount in moles

$$\left(\frac{54.5 \text{ g C}}{1}\right) \left(\frac{1 \text{ mol}}{12.01 \text{ g C}}\right) = 4.54 \text{ mol}$$

$$\left(\frac{9.2 \text{ g H}}{1}\right) \left(\frac{1 \text{ mol}}{1.008 \text{ g H}}\right) = 9.13 \text{ mol}$$

$$\left(\frac{36.3 \text{ g O}}{1}\right) \left(\frac{1 \text{ mol}}{16.00 \text{ g O}}\right) = 2.27 \text{ mol}$$

Divide each of the found values by the smallest of these values (2.27)

$$\frac{4.54 \text{ mol}}{2.27 \text{ mol}} = 2.00$$

$$\frac{9.13 \text{ mol}}{2.27 \text{ mol}} = 4.02$$

$$\frac{2.27 \text{ mol}}{2.27 \text{ mol}} = 1.00$$

Thus, the empirical formula of acetaldehyde is $\text{C}_2\text{H}_4\text{O}$. The molecular mass of acetaldehyde ($\text{C}_2\text{H}_4\text{O}$) is :

$$M(\text{C}_2\text{H}_4\text{O}) = 2 \cdot M(\text{C}) + 4 \cdot M(\text{H}) + M(\text{O}) = 2 \cdot 12.01 + 4 \cdot 1.008 + 16.00 = 44.05$$

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