

Pre-AP Chemistry
Unit #8—Chemical Quantities

Molecular Formulas

- Step 1 Convert mass to moles of given elements
 Step 2 Determine ratios of each element in formula
 Step 3 If ratios are not whole numbers.....
 Step 4 Write empirical formula
 Step 5 Calculate the molar mass of empirical formula
 Step 6 Determine the ratio for the molecular formula
 Step 7 Using the ratio, distribute to the empirical formula
 Step 8 Write the molecular formula

Succinic acid is a substance produced by lichens. Chemical analysis indicates it is composed of 40.68% carbon, 5.08% hydrogen, and 54.24% oxygen. It has a molar mass of 118.1 g/mol. Determine the empirical and molecular formulas.

- Step 1 Convert mass to moles of given elements. Round answers to 4th decimal.

$$C = \frac{40.68 \text{ g C}}{12.011 \text{ g C}} \times \frac{1 \text{ mol C}}{12.011 \text{ g C}} = 3.3869 \text{ mol C}$$

$$H = \frac{5.08 \text{ g H}}{1.008 \text{ g H}} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 5.0397 \text{ mol H}$$

$$O = \frac{54.25 \text{ g O}}{15.999 \text{ g O}} \times \frac{1 \text{ mol O}}{15.999 \text{ g O}} = 3.3908 \text{ mol O}$$

- Step 2 Determine ratios of each element in the formula. Round answers to 1st decimal.

$$C = \frac{3.3869 \text{ mol}}{3.3869 \text{ mol}} = 1$$

$$H = \frac{5.0397 \text{ mol}}{3.3869 \text{ mol}} = 1.5$$

$$O = \frac{3.3908 \text{ mol}}{3.3869 \text{ mol}} = 1$$

- Step 3 If ratios are not whole numbers.....

$$\begin{aligned} C &= 1 \times 2 = 2 \\ H &= 1.5 \times 2 = 3 \\ O &= 1 \times 2 = 2 \end{aligned}$$

- Step 4 Write the empirical formula



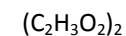
- Step 5 Calculate molecular mass/molar mass of the empirical formula

$$\begin{aligned} C &= 12.011 \text{ g/mol} \times 2 = 24.022 \text{ g/mol} \\ H &= 1.008 \text{ g/mol} \times 3 = 3.024 \text{ g/mol} \\ O &= 15.999 \text{ g/mol} \times 2 = 31.998 \text{ g/mol} \\ &= \frac{59.044 \text{ g/mol}}{59.044 \text{ g/mol}} \end{aligned}$$

- Step 6 Determine the ratio for the molecular formula

$$\frac{118.1 \text{ g/mol}}{59.044 \text{ g/mol}} = 2$$

- Step 7 Using the ratio, distribute to the empirical formula



- Step 8 Write the molecular formula

