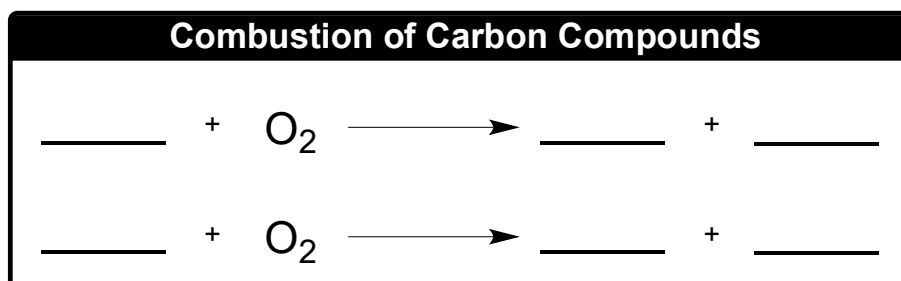


## CONCEPT: COMBUSTION ANALYSIS

● **Combustion Analysis** is an analytical process that determines the *empirical formula* of a compound.

- Normally combustion reactions involves a compound of \_\_\_\_\_ (*hydrocarbon*) or \_\_\_\_\_ reacting with  $O_2$ .
- The products formed are \_\_\_\_\_ and \_\_\_\_\_.



### Combustion of Carbon Compounds

**EXAMPLE:** 2,3-dihydroxysuccinic acid is responsible for the acidulous flavor of some candies and is composed of carbon, hydrogen, and oxygen. If combustion of 12.01 g of this acid creates 14.08 g  $CO_2$  and 4.32 g  $H_2O$ , what is its empirical formula?

**STEP 1:** Convert the grams of  $CO_2$  to grams of \_\_\_\_\_.

**STEP 2:** Convert the grams of  $H_2O$  to grams of \_\_\_\_\_.

**STEP 3:** If necessary, subtract the grams of **STEPS 1 & 2** from the grams of the sample to determine the 3<sup>rd</sup> element.

**STEP 4:** Convert all the masses into \_\_\_\_\_.

**STEP 5:** Divide each mole answer by the smallest mole value in order to obtain whole numbers for each element.

**STEP 6:** If you get a value of \_\_\_\_\_ or \_\_\_\_\_ then you can round to the nearest whole number.

- If you can't round, we multiply by a factor to create whole numbers.

**CONCEPT: COMBUSTION ANALYSIS**

**PRACTICE:** An unknown compound is composed of carbon, hydrogen and oxygen. A 4.30 g sample is ignited and creates 8.59 g CO<sub>2</sub> and 3.52 g H<sub>2</sub>O. If the molar mass is 176.22 g/mol, what is the molecular formula?

**PRACTICE:** In the presence of a small amount of oxygen a combustion reaction will not only produce carbon dioxide, but also carbon monoxide. The incomplete combustion of naphthalene, a hydrocarbon used in many dyes, produced 2.80 g CO, 4.40 g CO<sub>2</sub> and 1.44 g H<sub>2</sub>O. Determine its empirical formula.

## CONCEPT: COMBUSTION ANALYSIS

### Combustion of Non-Hydrocarbons

- A *non-hydrocarbon* represents a compound containing not only C and H, but also \_\_\_\_\_, \_\_\_\_\_ and/or a \_\_\_\_\_.
- Through combustion analysis, they can create gaseous products such as \_\_\_\_\_, \_\_\_\_\_ or a \_\_\_\_\_ molecule.

**EXAMPLE:** A solvating agent ( $M = 147.0$  g/mol) that contains C, H, and Cl is used for spectroscopic processes. Determine its molecular formula when 0.250 g sample creates 0.451 g  $\text{CO}_2$  and 0.0617 g of  $\text{H}_2\text{O}$  upon combustion.

**STEP 1:** If present, convert the grams of  $\text{CO}_2$  to grams of \_\_\_\_\_.

**STEP 2:** Convert the grams of  $\text{H}_2\text{O}$  to grams of \_\_\_\_\_.

**STEP 3:** If necessary, subtract the grams of **STEPS 1 & 2** from the grams of the sample to determine the 3<sup>rd</sup> element.

**STEP 4:** Convert all the masses into \_\_\_\_\_.

**STEP 5:** Divide each mole answer by the smallest mole value in order to obtain whole numbers for each element.

**STEP 6:** If you get a value of \_\_\_\_\_ or \_\_\_\_\_ then you can round to the nearest whole number.

- If you can't round, we multiply by the a factor to create whole numbers.

**CONCEPT: COMBUSTION ANALYSIS**

**PRACTICE:** A compound composed of carbon, hydrogen and nitrogen undergoes a combustion reaction to produce 264.21 g CO<sub>2</sub>, 63.06 g H<sub>2</sub>O and 46.4 g NO<sub>2</sub>. Determine its empirical formula.

**PRACTICE:** The combustion of 4.16 grams of a compound which contains only C,H,O and F yields 7.7 g CO<sub>2</sub> and 2.52 g H<sub>2</sub>O. Another sample of the compound with a mass of 3.63 g is found to contain 0.58 g F. What is the empirical formula of the compound?