Honors Chemistry                                   Name _____

Ms. Ye                                             Date _____Block_____

**Do Now: Empirical/Molecular Formula Review**

1. Determine the empirical formula of the given molecular formulas below

| Molecular Formula | Empirical Formula | Molecular Formula | Empirical Formula |
|---|---|---|---|
| $HgBr_2$ | | $C_8H_{14}$ | |
| $C_2H_6O$ | | $C_3H_6$ | |

2. Determine the molecular formula based on the information given

   a.

   | | | |
   |---|---|---|
   | Molecular Formula | | 84.18 g/mol |
   | Empirical Formula | $CH_2$ | |

   b.

   | | | |
   |---|---|---|
   | Molecular Formula | | 110.98 g/mol |
   | Empirical Formula | $CaCl_2$ | |

   c.

   | | | |
   |---|---|---|
   | Molecular Formula | | 120.12 g/mol |
   | Empirical Formula | $CH_2O$ | |

3. A compound has an empirical formula of $CF_3$ and a molar mass of 138.02 g/mol. What is the molecular formula of the compound?

**Determining Empirical Formulas from Mass Data**

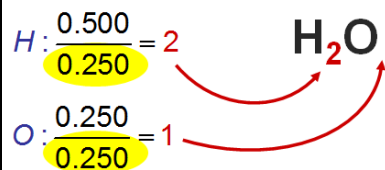| **Ex:** Assume you have a sample that is **0.504 g hydrogen** and **4.00 g oxygen.** | | |
|---|---|---|
| 1. **Convert grams → moles** for each element $H: 0.504\ g \times \dfrac{1\ mole}{1.01\ g} = 0.500\ moles$ $O: 4.00\ g \times \dfrac{1\ mole}{16.00\ g} = 0.250\ moles$ | 2. **Simplify the mole ratio** for each element by dividing each number (of moles) by the smallest # of moles $H:\ 0.500\ moles$ $O:\ 0.250\ moles$ smallest number of moles $H: \dfrac{0.500}{0.250} = 2$ $O: \dfrac{0.250}{0.250} = 1$ | 3. Use the **smallest whole-number mole ratio** as the subscripts for the empirical formula $H: \dfrac{0.500}{0.250} = 2$ $O: \dfrac{0.250}{0.250} = 1$ $H_2O$ |

**Practice:**

1. A 5.325 g sample of methyl benzoate, a compound used in the manufacture of perfumes, is found to contain **3.758 g of carbon, 0.316 g of hydrogen** and **1.251 g of oxygen**. What is the empirical formula of methyl benzoate?

2. A 24.98g sample of an unknown compound was analyzed and found to **contain 13.5 g Ca, 10.8 g O, and 0.675 g H**. What is the empirical formula of the compound?

## Determining Empirical Formulas from Percent Composition Data:

**Ex:** Determine the empirical formula for a compound containing **74.0% carbon (C), 8.65% hydrogen (H), and 17.3% nitrogen (N)** by mass.

| | |
|---|---|
| 1. **Assume a 100 gram sample for the compound**. The percent composition of each element will then be equal to the mass of the element found in the 100 g sample.<br><br>Assume a 100 g sample:<br>    C: 74.0 % → 74 g C in 100 g sample<br>    H: 8.65 % → 8.65 g H in 100 g sample<br>    N: 17.3% → 17.3 g N in 100 g sample | 2. **Convert grams → moles for each element**<br><br>C:    $74\ g\ C \times \frac{1\ mol\ C}{12.01\ g\ C} = \mathbf{6.16\ mol\ C}$<br><br>H:    $8.65\ g\ H \times \frac{1\ mol\ H}{1.01\ g\ H} = \mathbf{8.56\ mol\ H}$<br><br>N:    $17.3\ g\ N \times \frac{1\ mol\ N}{14.01\ g\ N} = \mathbf{1.23\ mol\ N}$ |
| 3. **Simplify the mole ratio** for each element by dividing each number (of moles) by the smallest # of moles<br><br>C:  $\frac{6.16}{1.23} = 5.01 \rightarrow \mathbf{5}$<br><br>H:  $\frac{8.56}{1.23} = 6.96 \rightarrow \mathbf{7}$<br><br>N:  $\frac{1.23}{1.23} = 1.00$ | 4. **Use the smallest whole-number mole ratio as the subscripts for the empirical formula**<br><br>C:  5<br><br>H:  7      $C_5H_7N$<br><br>N:  1 |

**Note:** If the simplified mole ratios are not all whole numbers, multiply by the smallest factor that will produce whole number subscripts

**Practice:**
1. A compound is found to contain **63.52% iron** and **36.48% sulfur**. Determine the empirical formula

2. A combustion analysis determined that the molecule consisted of 54.5% carbon, 9.15% hydrogen, and 36.3% oxygen.
   a. Determine the empirical formula.

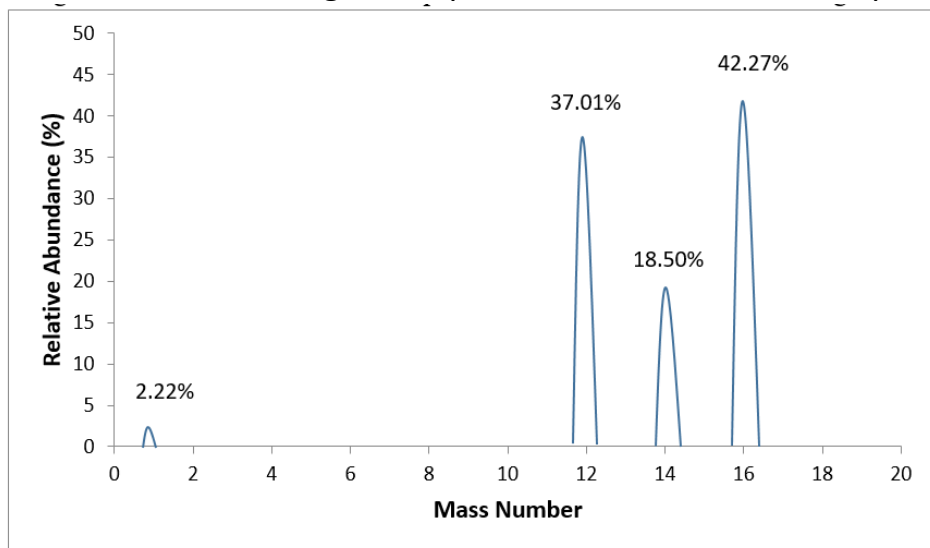   b. Determine the molecular formula knowing that the molecular mass = 132.16g/mol.

**Finding Empirical Formula from Percent Composition Data…what happens when your mole ratios aren't whole numbers?**

| If when you divide all the # of moles by the smallest # of moles and your mole ratios end in: | Multiply all mole ratios by _____ to get all whole numbers for your mole ratio |
|---|---|
| ~0.5 (1/2) | |
| ~.33 (1/3) , <br><br> ~.66 (2/3) | |
| ~0.25 (1/4), <br><br> ~0.75 (3/4) | |

**Examples**

3. A compound contains 25.94% Nitrogen and 74.06% oxygen by mass. What is the empirical formula?

4. A 10.0 gram sample of a compound contains 7.22 grams of magnesium and 2.78 grams of nitrogen. Determine the empirical formula.

**Determining EF AND MF WS**

1. Ascorbic Acid (vitamin C) is **40.92% Carbon, 4.58% Hydrogen and 54.50% Oxygen** by mass. Calculate the empirical formula of Ascorbic Acid.

2. An organic compound with a molecular mass of 140.0g/mol is 68.54% carbon, 8.63% hydrogen, and 22.83% oxygen.
   a) What is the empirical formula?

   b) What is the molecular formula of the compound?

3. NutraSweet is 57.14% C, 6.16% H, 9.52% N, and 27.18% O. Calculate the empirical formula of NutraSweet and find the molecular formula. (The molar mass of NutraSweet is 294.30 g/mol)

4. Caffeine is 49.5% carbon, 5.15% hydrogen, 28.9% nitrogen and 16.5% oxygen. The molecular weight is about 195g/mole. What is the molecular formula?

5.  Cadaverine, produced by the action of bacteria on meat, is 58.55% C, 13.81% H, 27.40% N.
    MW = 102.2 g/mole.  What is its molecular formula?

6.  Given the following mass spec data, determine the empirical formula of the compound.



What is the molecular formula if the molar mass of the compound is 227.1 g/mol?