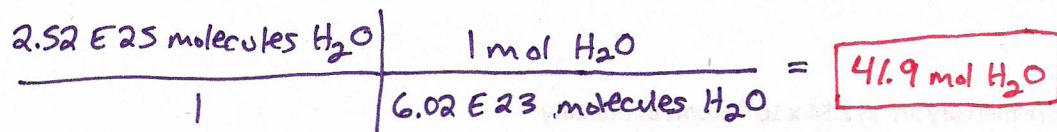


# ANSWER KEY

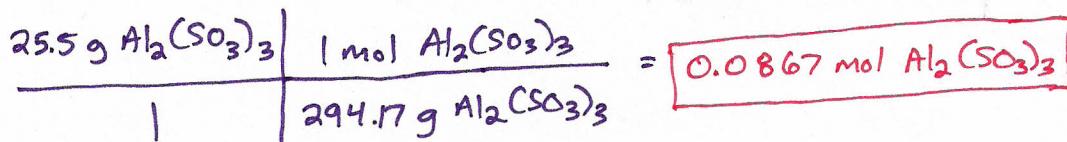
## EXTRA PRACTICE: Ch. 11 – The Mole & Chemical Quantities Name: \_\_\_\_\_

### Molar Mass/2-Step MOLE Conversions:

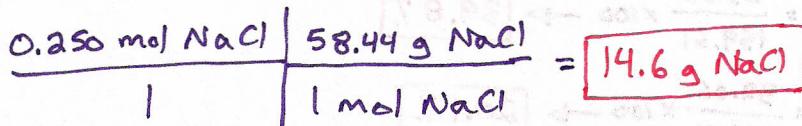
1. How many moles of water are there if you have  $2.52 \times 10^{25}$  molecules of water?



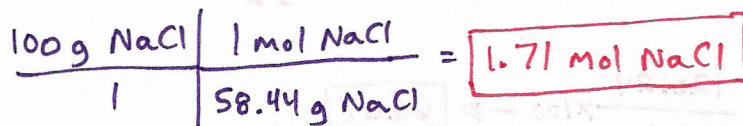
2. How many moles of aluminum sulfite are there in 25.5 grams of aluminum sulfite?



3. Calculate the mass in grams for 0.250 moles of sodium chloride.

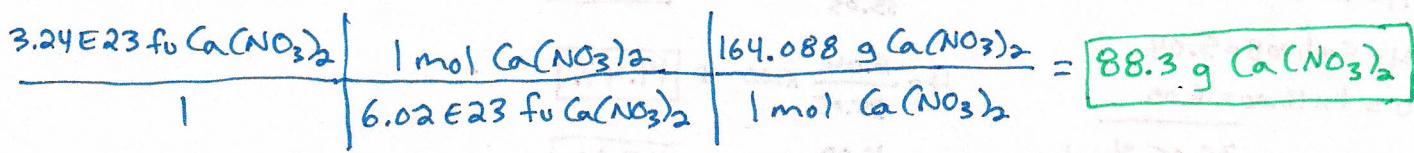


4. Calculate the number of moles in 100. grams of sodium chloride.

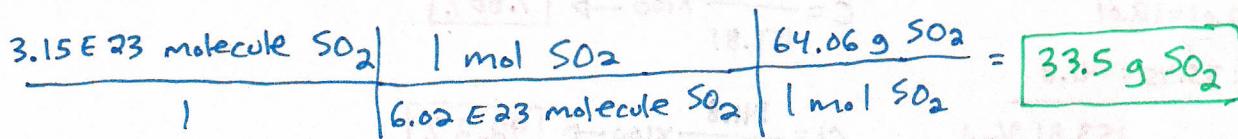


### 3-Step MOLE Conversions:

1. How many grams of calcium nitrate are in  $3.24 \times 10^{23}$  formula units (f.u.) of calcium nitrate?



2. How many grams of sulfur dioxide are in  $3.15 \times 10^{23}$  molecules of sulfur dioxide?



3. How many molecules of laughing gas (dinitrogen monoxide) are in  $1.78 \times 10^{23}$  grams of laughing gas?

$$\frac{1.78 \times 10^{23} \text{ g } \text{N}_2\text{O}}{1} \left| \begin{array}{c} 1 \text{ mol } \text{N}_2\text{O} \\ 44.01 \text{ g } \text{N}_2\text{O} \end{array} \right| \frac{6.02 \times 10^{23} \text{ molecule } \text{N}_2\text{O}}{1 \text{ mol } \text{N}_2\text{O}} = 2.44 \times 10^{45} \text{ molecule } \text{N}_2\text{O}$$

4. How many grams of pure mercury are in  $2.54 \times 10^{23}$  atoms of mercury?

$$\frac{2.54 \times 10^{23} \text{ atoms Hg}}{1} \left| \begin{array}{c} 1 \text{ mol Hg} \\ 6.02 \times 10^{23} \text{ atoms Hg} \end{array} \right| \frac{200.59 \text{ g Hg}}{1 \text{ mol Hg}} = 84.6 \text{ g Hg}$$

### Percent (%) Composition:

1. Determine the percent composition for each of the elements in copper (II) sulfate.  $\rightarrow \text{CuSO}_4$

$$\text{Cu} = 1 \times 63.55 = 63.55$$

$$\text{S} = 1 \times 32.06 = 32.06$$

$$\text{O} = 4 \times 16.00 = 64.00$$

$$159.61 \text{ g/mol}$$

$$\text{Cu} = \frac{63.55}{159.61} \times 100 \rightarrow 39.8\%$$

$$\text{S} = \frac{32.06}{159.61} \times 100 \rightarrow 20.1\%$$

$$\text{O} = \frac{64.00}{159.61} \times 100 \rightarrow 40.1\%$$

2. What is the percent composition of calcium in the compound calcium phosphide?  $\rightarrow \text{Ca}_3\text{P}_2$

$$\text{Ca} = 3 \times 40.08 = 120.24$$

$$\text{P} = 2 \times 30.97 = 61.94$$

$$182.18 \text{ g/mol}$$

$$\text{Ca} = \frac{120.24}{182.18} \times 100 \rightarrow 66.0\%$$

3. Determine the percent composition for each of the elements in ammonium hydroxide.  $\rightarrow \text{NH}_4\text{OH}$

$$\text{N} = 1 \times 14.01 = 14.01$$

$$\text{N} = \frac{14.01}{35.05} \times 100 \rightarrow 40.0\%$$

$$\text{H} = 5 \times 1.008 = 5.04$$

$$\text{H} = \frac{5.04}{35.05} \times 100 \rightarrow 14.4\%$$

$$\text{O} = 1 \times 16.00 = 16.00$$

$$\text{O} = \frac{16.00}{35.05} \times 100 \rightarrow 45.6\%$$

4. Determine the percent composition for each of the elements in carbon tetrachloride.  $\rightarrow \text{CCl}_4$

$$\text{C} = 1 \times 12.01 = 12.01$$

$$\text{C} = \frac{12.01}{153.81} \times 100 \rightarrow 7.80\%$$

$$\text{Cl} = 4 \times 35.45 = 141.8$$

$$153.81 \text{ g/mol}$$

$$\text{Cl} = \frac{141.8}{153.81} \times 100 \rightarrow 92.2\%$$

## Empirical Formulas (E.F.):

1. Determine the empirical formula (E.F.) of a compound containing 24.7% potassium, 34.8% manganese, and 40.5% oxygen.

$$\frac{24.7 \text{ g K}}{1} \left| \begin{array}{l} 1 \text{ mol K} \\ 39.10 \text{ g K} \end{array} \right. = \frac{0.6317 \text{ mol K}}{0.6317} \rightarrow 1$$

$$\frac{34.8 \text{ g Mn}}{1} \left| \begin{array}{l} 1 \text{ mol Mn} \\ 54.94 \text{ g Mn} \end{array} \right. = \frac{0.6334 \text{ mol Mn}}{0.6317} \rightarrow 1$$

$$\boxed{\text{E.F.} = \text{KMnO}_4}$$

$$\frac{40.5 \text{ g O}}{1} \left| \begin{array}{l} 1 \text{ mol O} \\ 16.00 \text{ g O} \end{array} \right. = \frac{2.531 \text{ mol O}}{0.6317} \rightarrow 4$$

2. Quantitative analysis shows that a compound contains 32.4% Na, 22.7% S, and 45.0% O. Calculate the Empirical Formula (E.F.) of this compound.

$$\frac{32.4 \text{ g Na}}{1} \left| \begin{array}{l} 1 \text{ mol Na} \\ 22.99 \text{ g Na} \end{array} \right. = \frac{1.41 \text{ mol Na}}{0.708} \rightarrow 2$$

$$\frac{22.7 \text{ g S}}{1} \left| \begin{array}{l} 1 \text{ mol S} \\ 32.06 \text{ g S} \end{array} \right. = \frac{0.708 \text{ mol S}}{0.708} \rightarrow 1$$

$$\boxed{\text{E.F.} = \text{Na}_2\text{SO}_4}$$

$$\frac{45.0 \text{ g O}}{1} \left| \begin{array}{l} 1 \text{ mol O} \\ 16.00 \text{ g O} \end{array} \right. = \frac{2.81 \text{ mol O}}{0.708} \rightarrow 4$$

3. Determine the empirical formula (E.F.) of a compound containing 67.6% mercury, 10.8% sulfur, and 21.6% oxygen.

$$\frac{67.6 \text{ g Hg}}{1} \left| \begin{array}{l} 1 \text{ mol Hg} \\ 200.59 \text{ g Hg} \end{array} \right. = \frac{0.337 \text{ mol Hg}}{0.337} \rightarrow 1$$

$$\frac{10.8 \text{ g S}}{1} \left| \begin{array}{l} 1 \text{ mol S} \\ 32.06 \text{ g S} \end{array} \right. = \frac{0.337 \text{ mol S}}{0.337} \rightarrow 1$$

$$\boxed{\text{E.F.} = \text{Hg SO}_4}$$

$$\frac{21.6 \text{ g O}}{1} \left| \begin{array}{l} 1 \text{ mol O} \\ 16.00 \text{ g O} \end{array} \right. = \frac{1.35 \text{ mol O}}{0.337} \rightarrow 4$$

4. A very flammable gas contains 60.0% Carbon and 40.0% Hydrogen. Calculate its Empirical Formula (E.F.).

$$\frac{60.0 \text{ g C}}{1} \left| \begin{array}{l} 1 \text{ mol C} \\ 12.01 \text{ g C} \end{array} \right. = \frac{4.96 \text{ mol C}}{4.96} \rightarrow 1$$

$$\boxed{\text{E.F.} = \text{CH}_8}$$

$$\frac{40.0 \text{ g H}}{1} \left| \begin{array}{l} 1 \text{ mol H} \\ 1.008 \text{ g H} \end{array} \right. = \frac{39.7 \text{ mol H}}{4.96} \rightarrow 8$$

## Molecular Formulas (M.F.):

1. The compound methyl butanoate smells like apples. Given its percent composition as 58.8% carbon, 9.80% hydrogen, and 31.4% oxygen and a M.F. molar mass of 102 g/mol, what is the molecular formula (M.F.) for methyl butanoate?

$$\frac{58.8 \text{ g C}}{1} \left| \begin{array}{l} 1 \text{ mol C} \\ 12.01 \text{ g C} \end{array} \right. = \frac{4.90 \text{ mol C}}{1.96} / \frac{9.80 \text{ g H}}{1} \left| \begin{array}{l} 1 \text{ mol H} \\ 1.008 \text{ g H} \end{array} \right. = \frac{9.72 \text{ mol H}}{1.96} / \frac{31.4 \text{ g O}}{1} \left| \begin{array}{l} 1 \text{ mol O} \\ 16.00 \text{ g O} \end{array} \right. = \frac{1.96 \text{ mol O}}{1.96} \\ \text{L} \rightarrow 2.5(2) = 5 \quad \text{L} \rightarrow 5(2) = 10 \quad \text{L} \rightarrow 1(2) = 2$$

$$\textcircled{1} \text{ E.F.} = \text{C}_5\text{H}_{10}\text{O}_2$$

$$\text{E.F. molar mass} = 102.13 \text{ g/mol}$$

$$\textcircled{2} \frac{\text{MF}}{\text{EF}} = \frac{102.13 \text{ g/mol}}{102.13 \text{ g/mol}} \rightarrow 1$$

$$\textcircled{3} 1 \times (\text{C}_5\text{H}_{10}\text{O}_2) \rightarrow$$

$$\textcircled{4} \boxed{\text{MF} = \text{C}_5\text{H}_{10}\text{O}_2}$$

2. Calculate the Molecular Formula of a compound containing 43.6% P and 56.4% O, if the M.F. molar mass is 284 g/mol.

$$\frac{43.6\text{ g P}}{1} \left| \begin{array}{l} 1 \text{ mol P} \\ | \\ 30.97 \text{ g P} \end{array} \right. = \frac{1.41 \text{ mol P}}{1.41} \quad / \quad \frac{56.4\text{ g O}}{1} \left| \begin{array}{l} 1 \text{ mol O} \\ | \\ 16.00 \text{ g O} \end{array} \right. = \frac{3.53 \text{ mol O}}{1.41} \rightarrow 2.5 \quad \hookrightarrow 2.5(2) = 5$$

① E.F. =  $P_2O_5$

E.F. molar mass = 141.94 g/mol

②  $\frac{MF}{EF} = \frac{284 \text{ g/mol}}{141.94 \text{ g/mol}} \rightarrow 2$

③  $2 \times (P_2O_5) \rightarrow$

④  $MF = P_4O_{10}$

3. The empirical formula of a compound is  $C_3H_7$ , with a M.F. molar mass of 86.0 g/mol. Calculate the Molecular Formula (M.F.).

① Given: E.F. =  $C_3H_7$

② E.F. molar mass = 43.086 g/mol

③  $\frac{MF}{EF} = \frac{86.0 \text{ g/mol}}{43.086 \text{ g/mol}} \rightarrow 2$

④  $2 \times (C_3H_7) \rightarrow$

⑤  $MF = C_6H_{14}$

4. The empirical formula of a compound is CH, with a M.F. molar mass of 26.0 g/mol. Calculate the Molecular Formula (M.F.).

① Given: E.F. = CH

② E.F. molar mass = 13.018 g/mol

③  $\frac{MF}{EF} = \frac{26.0 \text{ g/mol}}{13.018 \text{ g/mol}} \rightarrow 2$

④  $2 \times (CH) \rightarrow$

⑤  $MF = C_2H_2$

### Calculating Hydrates:

1. Hydrated sodium tetraborate, commonly called borax has the general formula  $Na_2B_4O_7 \cdot nH_2O$ . Chemical analysis indicates that this hydrate is 52.8% sodium tetraborate and 47.2% water. Determine the formula and name the hydrate.

$$\frac{52.8 \text{ g } Na_2B_4O_7}{1} \left| \begin{array}{l} 1 \text{ mol } Na_2B_4O_7 \\ | \\ 201.22 \text{ g } Na_2B_4O_7 \end{array} \right. = \frac{0.262 \text{ mol } Na_2B_4O_7}{0.262} \rightarrow 1$$

$$\frac{47.2 \text{ g } H_2O}{1} \left| \begin{array}{l} 1 \text{ mol } H_2O \\ | \\ 18.016 \text{ g } H_2O \end{array} \right. = \frac{2.62 \text{ mol } H_2O}{0.262} \rightarrow 10$$

\* Hydrate Formula =  $Na_2B_4O_7 \cdot 10H_2O$

\* Hydrate Name = Sodium Tetraborate Decahydrate