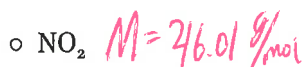


Quiz 3.4 – Empirical Analysis

Name: Key

Question 1 (2 point)

Give the percent composition for all elements in the following compounds:



$$\% \text{N} = \frac{14.01 \text{ g/mol}}{46.01 \text{ g/mol}} \cdot 100\% = 30.45\%$$

$$\% \text{O} = \frac{2 \cdot 16.00 \text{ g/mol}}{46.01 \text{ g/mol}} \cdot 100\% = 69.55\%$$



$$M = 64.51 \text{ g/mol}$$

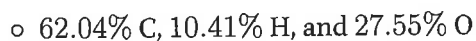
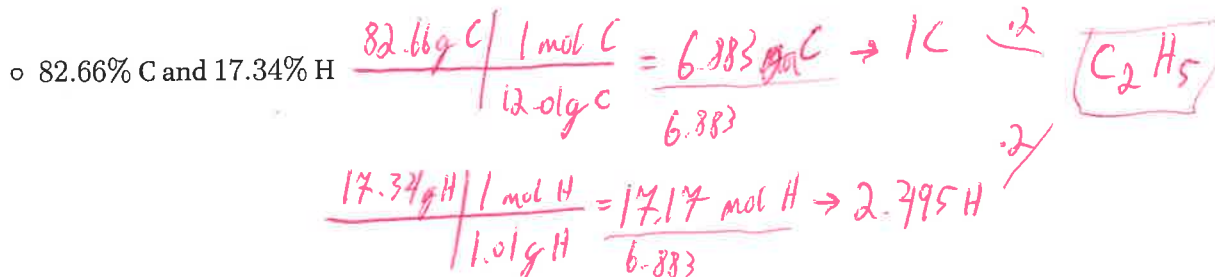
$$\% \text{C} = \frac{2 \cdot 12.01 \text{ g/mol}}{64.51 \text{ g/mol}} \cdot 100\% = 37.23\%$$

$$\% \text{H} = \frac{5 \cdot 1.01 \text{ g/mol}}{64.51 \text{ g/mol}} \cdot 100\% = 7.83\%$$

$$\% \text{Cl} = \frac{35.45 \text{ g/mol}}{64.51 \text{ g/mol}} \cdot 100\% = 54.95\%$$

Question 2 (2 points)

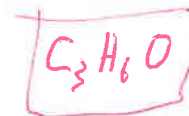
Give the empirical formula for compounds with the following compositions:



$$\frac{62.04 \text{ g C}}{12.01 \text{ g C}} = 5.166 \text{ mol C} \rightarrow 3 \text{ C} \quad 1.722$$

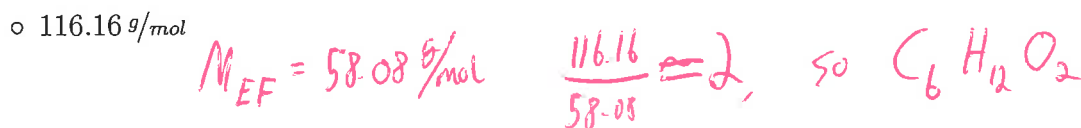
$$\frac{10.41 \text{ g H}}{1.01 \text{ g H}} = 10.3 \text{ mol H} \rightarrow 6 \text{ H} \quad 1.722$$

$$\frac{27.55 \text{ g O}}{16.00 \text{ g O}} = 1.722 \text{ mol O} \rightarrow 1 \text{ O} \quad 1.722$$



Question 3 (1 point)

What are the molecular formulas for the compounds in Question 2 if their molecular weights are:



Question 5 (2 points)

1.25 g of an unknown are combusted in excess O_2 to produce 4.28 g of CO_2 and 0.730 g of H_2O . A separate analysis gave the compound's molar mass as 154.211 g/mol

Give the empirical and molecular formulas for the unknown substance

$$\begin{array}{l}
 \frac{4.28 \text{ g } CO_2}{44.01 \text{ g } CO_2} \cdot \frac{1 \text{ mol } CO_2}{1 \text{ mol } CO_2} \cdot \frac{1 \text{ mol } C}{1 \text{ mol } C} = 0.09725 \text{ mol } C \cdot 12.011 \text{ g/mol} = 1.168 \text{ g } C \\
 \frac{0.730 \text{ g } H_2O}{18.02 \text{ g } H_2O} \cdot \frac{1 \text{ mol } H_2O}{1 \text{ mol } H_2O} \cdot \frac{2 \text{ mol } H}{2 \text{ mol } H} = 0.08102 \text{ mol } H \cdot 1.008 \text{ g/mol} = 0.08167 \text{ g } H
 \end{array}$$

$$\begin{array}{r}
 1.25 \text{ g} \\
 - 1.168 \text{ g} \\
 \hline
 0.08167 \text{ g} \\
 \hline
 \text{O (within error)}
 \end{array}$$

$$\begin{array}{l}
 0.09725 \text{ mol } C \cdot 12.011 \text{ g/mol} = 1.168 \text{ g } C \\
 0.08102 \text{ mol } H \cdot 1.008 \text{ g/mol} = 0.08167 \text{ g } H
 \end{array}$$

$$\begin{array}{l}
 1.200 = \frac{6}{5} \cdot 5 = 6 \\
 1 = \frac{5}{5} \cdot 5 = 5
 \end{array}$$

Empirical: $C_6H_5 \leftarrow M = 77 \text{ g/mol}$

$$\frac{154 \text{ g/mol}}{77 \text{ g/mol}} = 2 \quad \text{Molecular: } C_{12}H_{10}$$

Question 6 (3 points)

2.75 g of an unknown are combusted in excess O_2 to produce 3.94 g of CO_2 and 2.15 g of H_2O . A separate analysis gave the compound's molar mass as 92.095 g/mol

Give the empirical and molecular formulas for the unknown substance

$$\begin{array}{l}
 \frac{3.94 \text{ g } CO_2}{44.01 \text{ g } CO_2} \cdot \frac{1 \text{ mol } CO_2}{1 \text{ mol } CO_2} \cdot \frac{1 \text{ mol } C}{1 \text{ mol } C} = 0.08953 \text{ mol } C \cdot 12.011 \text{ g/mol} = 1.075 \text{ g } C \\
 \frac{2.15 \text{ g } H_2O}{18.02 \text{ g } H_2O} \cdot \frac{1 \text{ mol } H_2O}{1 \text{ mol } H_2O} \cdot \frac{2 \text{ mol } H}{2 \text{ mol } H} = 0.2386 \text{ mol } H \cdot 1.008 \text{ g/mol} = 0.2405 \text{ g } H
 \end{array}$$

$$\begin{array}{r}
 2.75 \text{ g} \\
 - 1.075 \text{ g} \\
 \hline
 0.2405 \text{ g} \\
 \hline
 1.434 \text{ g } O
 \end{array}$$

$$\begin{array}{l}
 0.08953 \text{ mol } C \cdot 12.011 \text{ g/mol} = 1.075 \text{ g } C \\
 0.2386 \text{ mol } H \cdot 1.008 \text{ g/mol} = 0.2405 \text{ g } H
 \end{array}$$

$$\begin{array}{l}
 1.434 \text{ g } O \\
 16.00 \text{ g } O
 \end{array}$$

$$\begin{array}{l}
 0.08953 \text{ mol } C \cdot 12.011 \text{ g/mol} = 1.075 \text{ g } C \\
 0.2386 \text{ mol } H \cdot 1.008 \text{ g/mol} = 0.2405 \text{ g } H
 \end{array}$$

$$\begin{array}{l}
 1.001 \approx \frac{3}{3} \cdot 3 = 3 \\
 2.665 \approx \frac{8}{3} \cdot 3 = 8
 \end{array}$$

Empirical = $C_3H_8O_3 \leftarrow 92 \text{ g/mol}$

Molecular = $C_3H_8O_3$