Chemical Formula Calculations
Chemistry 110

Set-ups must be shown where applicable. You will not receive credit for only answers shown.
Problem sets are due within the first five minutes of lecture on the due date.

1] What is the percentage by mass composition of Iron (III) oxide?

\[ \text{Fe}_{2}\text{O}_3 = 159.7 \text{ g/mol} \]

\[ \% \text{Fe} = \frac{2 \times 55.85 \text{ g/mol}}{159.7 \text{ g/mol}} \times 100 = 69.9\% \text{Fe} \]

\[ \% \text{O} = 100\% - 69.9\% = 30.1\% \text{ O} \]

2] Calculate the molar mass of C\(_3\)H\(_5\)N\(_3\)O\(_9\) (Nitroglycerin, an explosive)

\[ 3 \text{ C} = 3(12.0 \text{ g/mol}) = 36.0 \text{ g/mol} \]
\[ 5 \text{ H} = 5(1.0 \text{ g/mol}) = 5.0 \text{ g/mol} \]
\[ 3 \text{ N} = 3(14.0 \text{ g/mol}) = 42.0 \text{ g/mol} \]
\[ 9 \text{ O} = 9(16.0 \text{ g/mol}) = 144.0 \text{ g/mol} \]
\[ 227.0 \text{ g/mol} \]

3] How many atoms are found in 1.55 grams in chlorine gas?

\[ 1.55 \text{ g} \times \frac{1 \text{ mol Cl}_2}{71.0 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ Cl}_2 \text{ molecules}}{1 \text{ mole}} \times \frac{2 \text{ atoms Cl}}{1 \text{ molecule Cl}_2} = 2.62 \times 10^{22} \text{ atoms Cl} \]

4] When silver was selling for $16.00 per ounce, how many silver atoms could you buy for 10.00 dollars?

\[ $10.00 \times \frac{1 \text{ oz Ag}}{16.00 \text{ dollars}} \times \frac{28.34 \text{ g}}{1 \text{ oz Ag}} \times \frac{1 \text{ mol Ag}}{107.9 \text{ g Ag}} \times \frac{6.02 \times 10^{23} \text{ Ag atoms}}{1 \text{ mol Ag}} = 9.88 \times 10^{22} \text{ atoms} \]

5] How many grams of carbon are there in 14.0 g of Pb(C\(_2\)H\(_5\))\(_4\) (tetraethyllead, a gasoline additive)?

\[ 14.0 \text{ g Pb(C}_2\text{H}_5)_4 \times \frac{1 \text{ mol Pb(C}_2\text{H}_5)_4}{323.4 \text{ g Pb(C}_2\text{H}_5)_4} \times \frac{8 \text{ mol C}}{1 \text{ mol Pb(C}_2\text{H}_5)_4} \times \frac{12.0 \text{ g}}{1 \text{ mol C}} = 4.13 \text{ g C} \]

6] A mixture contains 10.00 g of NaBr and 5.00 g of BaBr\(_2\). What is the total number of moles of bromide ions in the mixture?

\[ 10.00 \text{ g NaBr} \times \frac{1 \text{ mol NaBr}}{102.9 \text{ g NaBr}} \times \frac{1 \text{ mol Br}}{1 \text{ mol NaBr}} = 0.09718 \text{ mol Br} \]
\[ 5.00 \text{ g BaBr}_2 \times \frac{1 \text{ mol BaBr}_2}{297.1 \text{ g BaBr}_2} \times \frac{2 \text{ mol Br}}{1 \text{ mol BaBr}_2} = 0.0337 \text{ mol Br} \]

\[ 0.09718 \text{ mol Br} + 0.0337 \text{ mol Br} = 0.1309 \text{ mol Br} \]

7] Determine the moles of sodium in 7.22 x 10\(^{10}\) kg of Na\(_2\)S\(_2\)O\(_3\)

\[ 7.22 \times 10^{10} \text{ Kg Na}_2\text{S}_2\text{O}_3 \times \frac{10^3 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol Na}_2\text{S}_2\text{O}_3}{157.9 \text{ g}} \times \frac{2 \text{ mol Na}}{1 \text{ mol Na}_2\text{S}_2\text{O}_3} = 9.14 \times 10^{10} \text{ mol} \]

8] How many atoms of Zn would contain the same number of grams as 7.54 x 10\(^{-6}\) mg of Cu?

\[ 7.54 \times 10^{-6} \text{ mg Cu} \times \frac{10^{-3} \text{ g}}{1 \text{ mg}} = 7.54 \times 10^{-9} \text{ g Cu} \]

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9] What is the total number of atoms in 8.00 mole aluminum dichromate?

\[
8.00 \text{ mol } \text{Al}_2(\text{Cr}_2\text{O}_7)_3 \times \frac{6.02 \times 10^{23} \text{ formula units } \text{Al}_2(\text{Cr}_2\text{O}_7)_3}{1 \text{ mol } \text{Al}_2(\text{Cr}_2\text{O}_7)_3} \times \frac{29 \text{ atoms}}{1 \text{ formula unit}} = 1.40 \times 10^{26} \text{ total atoms}
\]

10] A typical aspirin tablet contains 5.0 grains of acetyl salicylic acid, C9H8O4. How many moles of acetyl salicylic acid are in a single tablet?(0.0648 g = 1.00 grain)

\[
5.0 \text{ grain} \times \frac{0.0648 \text{ g}}{1.00 \text{ grain}} \times \frac{1 \text{ mol C}_9\text{H}_8\text{O}_4}{180.2 \text{ g C}_9\text{H}_8\text{O}_4} = 1.5 \times 10^{-3} \text{ mol C}_9\text{H}_8\text{O}_4
\]

11] 4.159 g of a iron and sulfur containing compound is decomposed to give 2.233g of iron. What is the empirical formula?

\[
\begin{align*}
\text{Fe} & \quad 2.233 \text{ g} \div 55.8 \text{ g/mol} = 0.0400 \text{ mol Fe} \\
\text{S} & \quad (4.159 - 2.233) \text{ g} \div 32.1 \text{ g/mol} = 0.0600 \text{ mol S}
\end{align*}
\]

\[
\text{Fe} \quad 0.04 \quad \text{S} \quad 0.06
\]

\[
= \text{Fe}_1\text{S}_{1.5} \times 2
\]

\[
=> \text{Fe}_2\text{S}_3
\]

12] The percent composition of a compound is 20.0% C, 2.2% H, and 77.8% Cl. The molar mass of the compound is 182.0 g/mol

a. Find the empirical formula

\[
\begin{align*}
\text{C} & \quad 20.0 \text{ g} \div 12.0 \text{ g/mol} = 1.67 \text{ mol C} \\
\text{H} & \quad 2.2 \text{ g} \div 1.0 \text{ g/mol} = 2.2 \text{ mol H} \\
\text{Cl} & \quad 77.8 \text{ g} \div 35.5 \text{ g/mol} = 2.19 \text{ mol Cl}
\end{align*}
\]

\[
\text{C} \quad 1.67 \quad \text{H} \quad 2.2 \quad \text{Cl} \quad 2.19
\]

\[
= \text{C}_{1.32}\text{H}_{1.32}\text{Cl}_{1.32} \times 3
\]

\[
=> \text{C}_3\text{H}_4\text{Cl}_4
\]

b. Find the molecular formula

\[
\begin{align*}
3 \text{ C} & \quad = 3 \times 12.0 \text{ g/mol} \\
4 \text{ H} & \quad = 4 \times 1.0 \text{ g/mol} \\
4 \text{ Cl} & \quad = 4 \times 35.5 \text{ g/mol}
\end{align*}
\]

\[
\frac{182.0 \text{ g/mol}}{182} \text{ g} = 1 \Rightarrow \quad \text{C}_3\text{H}_4\text{Cl}_4
\]