Empirical formulas:

the simplest formula for a compound written in smallest whole number ratios
Which of these IS an empirical formula?

H₂O₂
C₂H₄
C₃H₆  CH₄  C₆H₂O₆  C₄H₈
Steps for Determining Empirical Formula (Summarized)

A compound contains 4.8 g N and 8.16 g O. What is the empirical formula?

1. Start with grams (Convert % comp to grams by assuming 100 g)

   4.8 g N
   8.16 g O

2. Convert grams to moles.

   \[
   \frac{4.8 \text{ g N}}{14 \text{ g/mol}} = 0.34 \text{ mol N} \\
   \frac{8.16 \text{ g O}}{16 \text{ g/mol}} = 0.51 \text{ mol O}
   \]

3. Find element with smallest number of moles.

   0.34 mol N is the smallest

4. Divide each amount of moles by smallest number of moles.

   \[
   \frac{0.34 \text{ mol N}}{0.34} = 1 \\
   \frac{0.51 \text{ mol O}}{0.34} = 1.5
   \]

5. Depending on the tenths place either round to nearest whole number OR multiply each number the same factor to get the smallest whole number ratio.

   \[
   1 \text{ N} \times 2 = 2 \text{ N} \\
   1.5 \text{ O} \times 2 = 3 \text{ O}
   \]

   \[
   \text{N}_2\text{O}_3
   \]
21.52 g K  
8.82 g S  
17.62 g O

1. Start with grams (Convert % comp to grams by assuming 100 g)

2. Convert grams to moles.

3. Find element with **smallest** number of moles.

4. Divide each amount of moles by smallest number of moles.

5. Depending on the tenths place either round to nearest whole number **OR** multiply each number the same factor to get the smallest **whole number** ratio.
1. Start with grams (Convert % comp to grams by assuming 100 g)

75% C  25% H

2. Convert grams to moles.

3. Find element with smallest number of moles.

4. Divide each amount of moles by smallest number of moles.

5. Depending on the tenths place either round to nearest whole number OR multiply each number the same factor to get the smallest whole number ratio.
3. MgCl$_2$

5. CaO
2. $\text{KCl}$

4. $\text{MgBr}_2$
1. CH₄
2. KCl
3. AlPO₄
4. MgBr₂
5. Na₂SO₄
1. Start with grams (Convert % comp to grams by assuming 100 g)

\[
\begin{align*}
32.4\% \text{ Na} & \quad 22.5\% \text{ S} & \quad 45.1\% \text{ O} \\
32.4 \text{ g Na} & \quad 22.5 \text{ g S} & \quad 45.1 \text{ g O}
\end{align*}
\]

2. Convert grams to moles.

\[
\frac{32.4 \text{ g Na}}{23 \text{ g mol}} = 1.4 \text{ mol} \quad \frac{22.5 \text{ g S}}{32 \text{ g mol}} = 0.7 \text{ mol} \quad \frac{45.1 \text{ g O}}{16 \text{ g mol}} = 2.8 \text{ mol}
\]

3. Find element with **smallest** number of moles.

\[0.7 \text{ mol}\]

4. Divide each amount of moles by smallest number of moles.

\[
\frac{1.4}{0.7} = 2 \quad \frac{0.7}{0.7} = 1 \quad \frac{2.8}{0.7} = 4
\]

5. Depending on the tenths place either round to nearest whole number **OR** multiply each number the same factor to get the smallest **whole number** ratio.

\[
\text{Na}_2 \text{SO}_4
\]
1. $\text{K}_2\text{SO}_4$
2. $\text{HgO}$
3. $\text{MgCl}_2$
4. $\text{BaCl}_2$
5. $\text{CaO}$
6. $\text{K}_2\text{Cr}_2\text{O}_7$
1. Start with grams (Convert % comp to grams by assuming 100 g)

\[ 4.78 \text{ g K} \quad 6.37 \text{ g Cr} \quad 6.82 \text{ g O} \]

2. Convert grams to moles.

\[ \frac{4.78 \text{ g K}}{39 \text{ g/mol}} = 0.12 \text{ mol} \quad \frac{6.37 \text{ g Cr}}{52 \text{ g/mol}} = 0.12 \text{ mol} \quad \frac{6.82 \text{ g O}}{16 \text{ g/mol}} = 0.43 \text{ mol} \]

3. Find element with \textbf{smallest} number of moles.

\[ 0.12 \text{ mol} \]

4. Divide each amount of moles by smallest number of moles.

\[ \frac{0.12}{0.12} = 1 \quad \frac{0.12}{0.12} = 1 \quad \frac{0.43}{0.12} = 3.5 \]

5. Depending on the tenths place either round to nearest whole number \textbf{OR} multiply each number the same factor to get the smallest \textbf{whole number} ratio.

\[ 1 \times 2 = 2 \quad 1 \times 2 = 2 \quad 3.5 \times 2 = 7 \]

\[ \text{K}_2 \text{Cr}_2 \text{O}_7 \]