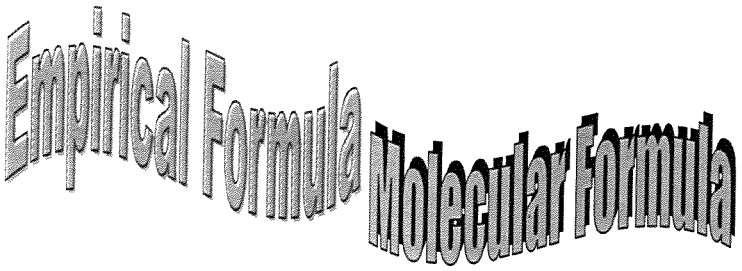
Example Problems Worked Out



Finding an Empirical Formula from Experimental Data

1. Find # of g of each element
2. Convert each g to mol
3. Divide each "# of mol" by the smallest "# of mol."
4. Use ratio to find formula

A compound is 45.5% yttrium and 54.5% chlorine.
Find its empirical formula.

$45.5\,g\,Y \left| \frac{1\,mol\,Y}{88.9\,g\,Y} \right. = .512\,mol\,Y / .512 \rightarrow 1$

$54.5\,g\,Cl \left| \frac{1\,mol\,Cl}{35.5\,g\,Cl} \right. = 1.535\,Cl / .512 \rightarrow 3$

YCl_3

A 17.40 g sample of a technetium/oxygen compound contains 11.07 g of Tc. Find the empirical formula.

$11.07\,g\,Tc \left| \frac{1\,mol\,Tc}{98\,g} \right. = .113\,mol\,Tc / .113 = 1$

TcO_9

$16.33\,g\,O \left| \frac{}{16.00} \right. 1.02\,mol\,O / .113 = 9$

A compound is found to contain the following % by mass: 69.58% Ba, 6.090% C, 24.32% O. What is the simplest (i.e. empirical) formula?

$69.58\,g\,Ba \left| \frac{1\,mol\,Ba}{137.33\,g\,Ba} \right. = .5067\,mol\,Ba / .5067 \rightarrow 1$

$6.090\,g\,C \left| \frac{1\,mol\,C}{12.01} \right. = .5075\,mol\,C / .5067 \rightarrow 1$

$24.32\,g\,O \left| \frac{1\,mol\,O}{16.00} \right. = 1.52\,mol\,O / .5067 \Rightarrow 2.999 \rightarrow 3$

$BaCO_3$

A ruthenium/sulfur compound is 67.7% Ru.
Find its empirical formula

$67.7\,g\,Ru \left| \frac{1\,mol\,Ru}{101.1\,g\,Ru} \right. = .670\,mol\,Ru / .670 \rightarrow 1 \times 2$

$32.3\,g\,S \left| \frac{1\,mol\,S}{32.1\,g\,S} \right. = 1.006\,mol\,S / .670 \rightarrow 1.5 \times 2$

$RuS_{1.5} \rightarrow Ru_2S_3$

A compound is composed of 7.20 g carbon, 1.20 g hydrogen, and 9.60 g oxygen. Find the empirical formula for this compound.

$7.20\text{g C} \left| \frac{1\text{mol C}}{12.01} \right. = .600\text{mol C} / .600 \rightarrow 1$ $\quad \frac{9.60\text{g O}}{16.00} \left| \frac{1\text{mol O}}{} \right. = .600\text{mol O} / .600 \rightarrow 1$

$1.20\text{g H} \left| \frac{1\text{mol H}}{1.01} \right. = 1.19\text{mol H} / .600 = 1.98 \rightarrow 2$ $\quad \boxed{CH_2O}$

A compound consists of 29.1 % Na, 40.5 % S, and 30.4 % O. Determine the simplest formula.

$29.1\text{g Na} \left| \frac{1\text{mol Na}}{22.9} \right. = 1.265\text{mol Na} / 1.263 = 1$ $\quad \frac{30.4\text{g O}}{16.00} = 1.9 / 1.263 = 1.5$

$40.5\text{g S} \left| \frac{1\text{mol S}}{32.07} \right. = 1.263\text{mol S} / 1.263 = 1$ $\quad Na_1S_1O_{1.5} \rightarrow \boxed{Na_2S_2O_3}$

To find molecular formula

1. Find empirical formula
2. Find molar mass of empirical formula.
3. Find n = $\frac{\text{mm molecular}}{\text{mm empirical}}$
4. Multiply all parts of empirical formula by n

Combustion analysis gives the following: 26.7% C, 2.2% hydrogen, 71.1% oxygen. If the molecular mass of the compound is 90 g/mol, determine its molecular formula

$26.7\text{g C} \left| \frac{1\text{mol}}{12.01\text{g}} \right. = 2.22\text{mol C} / 2.18 \rightarrow 1.02 \rightarrow 1$ $\quad CHO_2$ $\quad 90/45 = 2$

$2.2\text{g H} \left| \frac{1\text{mol}}{1.01\text{g H}} \right. = 2.18\text{mol H} / 2.18 \rightarrow 1$ $\quad$ Empirical 45g/mol $\quad \boxed{C_2H_2O_4}$

$\frac{71.1\text{g O}}{16.00} = 4.44\text{mol O} / 2.18 \rightarrow 2.04 \rightarrow 2$

A compound's empirical formula is CH, and it weighs 104 g/mol. Give the molecular formula.

$CH = 13$

$104/13 \rightarrow 8$ $\quad \boxed{C_8H_8}$

A substance is decomposed and found to consist of 53.2% C, 11.2% H, and 35.6% O by mass. Calculate the molecular formula of the unknown if its molar mass is 90 g/mol.

$53.2\text{g C} \left| \frac{1\text{mol C}}{12.01\text{g C}} \right. = 4.43\text{mol C} / 2.23 = 2$

$11.2\text{g H} \left| \frac{1\text{mol H}}{1.01\text{g H}} \right. = 11.09\text{mol H} / 2.23 \rightarrow 5$ $\quad C_2H_5O \rightarrow$ Empirical $\quad \frac{90}{45} = 2 \quad \boxed{C_4H_{10}O_2}$

$35.6\text{g O} \left| \frac{1\text{mol O}}{16.00} \right. = 2.23\text{mol O} / 2.23 \rightarrow 1$ $\quad 45\text{g/mol}$

A carbon/hydrogen compound is 7.7% H and has a molar mass of 78 g. Find its molecular formula.

$7.7\text{g H} \left| \frac{1\text{mol H}}{1.01\text{g}} \right. = 7.6\text{mol H} / 7.6 \rightarrow 1$ $\quad CH \rightarrow$ empirical $\quad \frac{78}{13} = 6 \quad \boxed{C_6H_6}$

$92.3\text{g C} \left| \frac{1\text{mol}}{12.01} \right. = 7.68 / 7.6 \rightarrow 1$ $\quad 13\text{g/mol}$

A compound has 26.33 g nitrogen, 60.20 g oxygen, and molar mass 92 g. Find molecular formula

$26.33\text{g N} \left| \frac{1\text{mol N}}{14.01\text{g N}} \right. = 1.88\text{mol N} / 1.88 \rightarrow 1$ $\quad NO_2 \rightarrow$ Empirical $\quad \frac{92}{46.01} = 2 \quad \boxed{N_2O_4}$

$\frac{60.20\text{g O}}{16.00} = 3.76\text{mol O} / 1.88 \rightarrow 2$ $\quad 46.01\text{g/mol}$