Na Key
B Date:

Chemistry 11
EMPIRICAL FORMULA

The EMPIRICAL FORMULA is also known as the SIMPLEST FORMULA

Example 1. What do the following compounds all have in common?
C_2H_4 , C_3H_6 , C_4H_8 , C_5H_{10} and C_6H_{12} ?

ALL CMPDS contain TWICE as many H's as C's.

∴ The Empirical Formula for the above compounds is CH_2 !!!!

To solve for the empirical formula we are going to work backwards from the Percent Composition values to determine the chemical formula.

Example 2. What is the EMPIRICAL FORMULA for a compound that is composed of 80.0 % Carbon and 20.0 % Hydrogen?

Step 1. Assume you have 100.0 grams

80.0% of 100.0g = 80.0g C

20.0% of 100.0g = 20.0g H

Step 2. Determine the # of moles of each element present

$80.0\text{g C} \times \frac{1\text{ mol C}}{12.0\text{g C}} = 6.67\text{ mol C}$

$20.0\text{g H} \times \frac{1\text{ mol H}}{1.0\text{g H}} = 20.0\text{ mol H}$

Step 3. Find the SMALLEST WHOLE-NUMBER mole RATIO!! → DIVIDE by smallest #

6.67 mol C ÷ 6.67 = 1 mol C

20.0 mol H ÷ 6.67 ≅ 3 mol H

Step 4. Write out the EMPIRICAL FORMULA

CH_3

Example 2. A compound is known to contain 58.5 % Carbon, 7.3 % Hydrogen and 34.1 % Nitrogen. What is the EMPIRICAL FORMULA for the compound?

Step 1. Assume you have 100.0 grams

58.5g C
7.3g H
34.1g N

Step 2. Determine the # of moles of each element present

$58.5\text{g C} \times \frac{1\text{ mol C}}{12.0\text{g C}} = 4.88\text{ mol C}$

$7.3\text{g H} \times \frac{1\text{ mol H}}{1.0\text{g H}} = 7.3\text{ mol H}$

$34.1\text{g N} \times \frac{1\text{ mol N}}{14.0\text{g N}} = 2.44\text{ mol N}$

Step 3. Find the SMALLEST WHOLE-NUMBER mole RATIO!!

4.88 mol C ÷ 2.44 = 2 mol C

7.3 mol H ÷ 2.44 = 2.99 ≅ 3 mol H

2.44 mol N ÷ 2.44 = 1 mol N

Step 4. Write out the EMPIRICAL FORMULA

C_2H_3N

Example 3. What is the EMPIRICAL FORMULA of a compound that contains 81.8 % C and 18.2 %H?

Step 1. Assume you have 100.0 grams

81.8 g C

18.2 g H

Step 2. Determine the # of moles of each element present

$81.8\ g\ C \times \frac{1\ mol\ C}{12.0\ g\ C} = 6.82\ mol\ C$ $\quad 18.2\ g\ H \times \frac{1\ mol\ H}{1.0\ g\ H} = 18.2\ mol\ H$

Step 3. Find the SMALLEST **WHOLE-NUMBER** mole **RATIO!!**

6.82 mol ÷ 6.82 = 1 mol C

18.2 mol ÷ 6.82 = 2.67 mol H ≠ 3 mol H !!!

PROBLEM!!!! You must be able to recognize the following fractional equivalents:

0.20 = 1/5	0.40 = 2/5	0.67 = 2/3
0.25 = 1/4	0.50 = 1/2	0.75 = 3/4
0.33 = 1/3	0.60 = 3/5	0.80 = 4/5

YOU ARE NOT CLOSE ENOUGH TO A WHOLE NUMBER RATIO TO ROUND, THEREFORE YOU MUST multiply both values by the denominator of the fractional equivalent

0.67 = 2/3 ∴ 1 mol C * 3 = 3 mol C

2.67 mol H * 3 = 8 mol H

Step 4. Now you can write out the EMPIRICAL FORMULA

C_3H_8

Sample Problem: What is the empirical Formula of a compound containing 39.0 % Si and 61.0 % O?

E.F = Si_4O_{11}

$39.0\ g\ Si \times \frac{1\ mol\ Si}{28.1\ Si} = 1.39\ mol\ Si \div 1.39 = 1\ mol\ Si \times 4 = 4\ mol\ Si$

$61.0\ g\ O \times \frac{1\ mol\ O}{16.0\ g\ O} = 3.81\ mol\ O \div 1.39 = 2.74\ mol\ O \times 4 = 11\ mol\ O$

0.75 ∴ 3/4

∴ Si_4O_{11}