Empirical and Molecular Formula

EMPIRICAL FORMULA- the molecular ratio of atoms in a molecule

1) **A COMPOUND CONTAINS 43.0% CARBON AND 57.0% OXYGEN. DETERMINE THE EMPIRICAL FORMULA.**

   a. In 100.0g, there will be

      i. 43.0g of C

      ii. 57.0g of O

   Find the number of moles of each:

   a. n_c = m/M

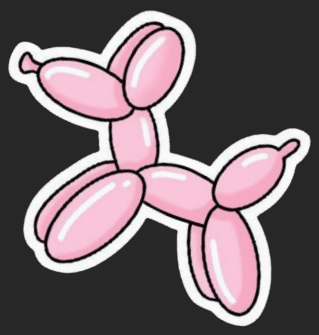
      = 43.0g / 12.01g/mol

      = 3.58 mol

   b. n_o = m/M

      = 57.0g/ 16.00 g/ mol

      = 3.56 mol



C:O = $\frac{3.58 \text{ mol}}{3.56 \text{ mol}} : \frac{3.56 \text{ mol}}{3.56 \text{ mol}}$

Divide each number by the smallest number:

C : O = 1:1

2) **A TYPE OF FUEL CONTAINS 56.0% CARBON, 7.0% HYDROGEN AND THE REST ARE OXYGEN. DETERMINE THE EMPIRICAL FORMULA OF THIS COMPOUND.**

   a. In 100.0g, there will be

      i. 56.0g of C

      ii. 7.0g of H

      iii. 100.0g - (56.0g + 37.0g) = 37.0g of O

   Find the number of moles for each

   a. n_c = m/M

      = 56.0g / 12.0g/mol

      = 4.66g/mol

   b. n_H = m/M

      = 7.0g / 1.01 g/mol

      = 6.9 mol

c. $n_o = m/M$

$= 37.0g/16.00g/mol$

$= 2.31\ mol$

$$C:H:O = \frac{4.66\ mol}{2.31\ mol} : \frac{6.9\ mol}{2.31\ mol} : \frac{2.31\ mol}{2.31\ mol}$$

Divide by smallest number.

C:H:O = 2:3:1

Empirical formula is C_2H_3O

Molecular Formula

Remember, Empirical formula gives the simplest whole number ratio of atoms

MOLECULAR FORMULA- gives the exact number of atoms in each molecule

1) A COMPOUND WITH AN EMPIRICAL FORMULA CH_2 WAS FOUND TO HAVE A MOLAR MASS OF 42.09 G/MOL. DETERMINE THE MOLECULAR FORMULA.

$M(CH_2)$ = 12.01 g/mol + 2 (1.01) g/mol

= 14.03 g/mol

$M(C_xH_{2x})$ = 42.09 g/mol (molecular)

Divide the molar mass of the molecule formula by the molar mass of the empirical formula.

$$\frac{M(C_xH_{2x})}{M(CH_2)} = \frac{42.09 g/mol}{14.03 g/mol}$$

∴ Molecular formula C_3H_6

2) AN UNKNOWN SAMPLE HAS 47.1% C, 6.6% H, AND 46.3% CL. IF THE MOLAR MASS OF THIS COMPOUND IS 153G/MOL, WHAT IS THE MOLECULAR FORMULA OF THIS COMPOUND?

In a 100g sample

Element	Mass	Molar Mass	Actual # moles	Relative # moles
C	47.1 g	12.01 g/mol	3.92 mol / 1.31	2.99 ~ 3
H	6.6 g	1.01 g/mol	6.53 mol / 1.31	4.98 ~ 5
Cl	46.3 g	35.45 g/mol	1.31 mol / 1.31	1

Empirical Formula = C_3H_5Cl

$M(C_3H_5Cl)$ = 3(12.01)g/mol + 5(1.01)g/mol + 35.45g/mol

= 76.53 g/mol

$M(C_{3x}H_{5x}Cl_x)$ = 153.0g/mol

X= 2 ∴ The molecular formula is $C_6H_{10}Cl_2$