SCH 3U
EMPIRICAL & MOLECULAR FORMULAS

$$P_4O_{10} \longrightarrow P_2O_5$$

molecular formula   empirical formula

[composition of 1 molecule]   [simplest formula of a compound]

[smallest ratio of atoms in the molecule]
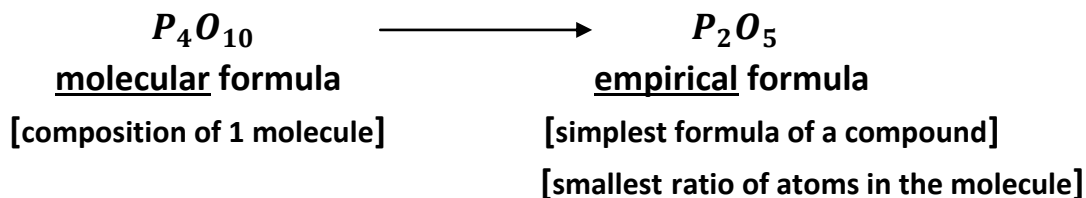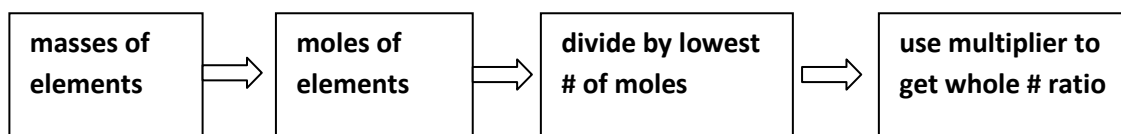
Determining the empirical formula of a compound (based on mass data) lies in the fact that moles of atoms always combine in the same ratio as the individual atoms themselves.

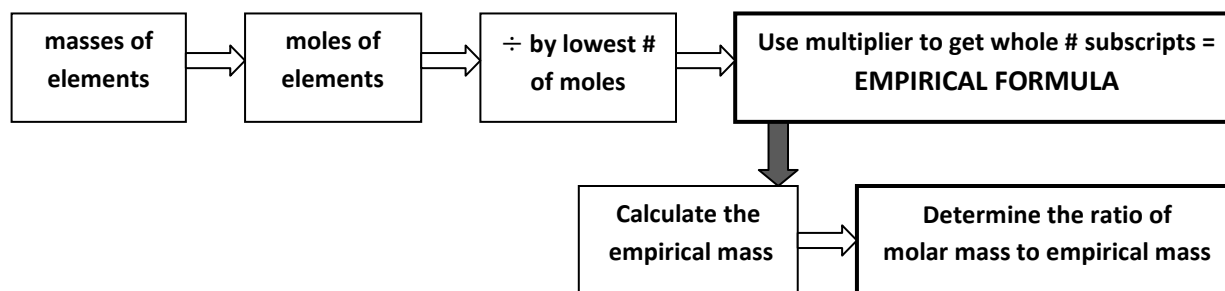## To determine the *EMPIRICAL FORMULA* of a compound:

masses of elements		moles of elements		divide by lowest # of moles		use multiplier to get whole # ratio

EXAMPLES

① A 2.012 g sample of a compound between nitrogen and oxygen contains 0.5219 g of nitrogen.
Calculate the empirical formula.

MULTIPLIERS	
when the decimal ends in...	multiply by...
0.5	2
0.33, 0.67	3
0.25, 0.75	4
0.2, 0.4, 0.6, 0.8	5
0.17	6

② A compound consists of 40.1% sulfur and 59.9% oxygen (by mass). What is its empirical formula? [Assume a 100-g sample]

To determine the *MOLECULAR FORMULA* of a compound:

masses of elements		moles of elements		÷ by lowest # of moles		Use multiplier to get whole # subscripts = EMPIRICAL FORMULA

Calculate the empirical mass		Determine the ratio of molar mass to empirical mass

If the **empirical formula** and **molar mass** of a compound are known, we can determine its molecular formula.

$$MOLECULAR\ FORMULA = \frac{molar\ mass}{empirical\ mass} \times (empirical\ formula)$$

__GIVEN:__ A compound has a molar mass of 56.12 g and its empirical formula is CH_2.

Empirical mass =   1- C = 12.01 g
                      2- H =   2.02 g
                              14.03 g

$$\frac{molar\ mass}{empirical\ mass} = \frac{56.11g}{14.03g} = 4$$

∴ molecular formula = $4 \times CH_2 = C_4H_8$

EXAMPLES:

① If empirical formula of lactic acid is CH_2O and its molar mass is 90.09 g, what is the molecular formula of lactic acid?

② A compound consists of 43.7% P and 56.3% O. What is the molecular formula if its molar mass is 425.82 g?

③ A compound consists of 89.9% carbon and 10.1% hydrogen. What is the molecular formula if its molar mass is 160.28 g?

④ A compound contains 64.8% carbon, 13.6% hydrogen and 21.6% oxygen by mass. Find the molecular formula of the compound, given that its molar mass is 148.28 g/mol.