

Calculating Molecular Formulas

- as was mentioned in section 10-4, many different molecular formulas can share the same empirical formula because we have reduced/simplified larger molecular formulas to do so.

ex) CH is an empirical formula for acetylene
 C_2H_2 & benzene C_6H_6

- each formula has a unique mass (GFM)
molar

ex) acetylene, $C_2H_2 = 26 \text{ g/mol}$

benzene, $C_6H_6 = 78 \text{ g/mol}$

* We can determine the molecular formula of a compound if we know the empirical formula and its gram formula mass (Molar Mass)

to solve,
$$\frac{\text{Gram formula Mass}}{\text{Empirical formula Mass}}$$

Given
$$\frac{\text{GFM}}{\text{EFM}} = \frac{\text{molar mass}}{\text{EFM}}$$

ex) Empirical formula = CH_4N , ^{gram} formula mass = 60 g/mol
 Molecular formula = ?

1st - determine the EFM by adding up masses

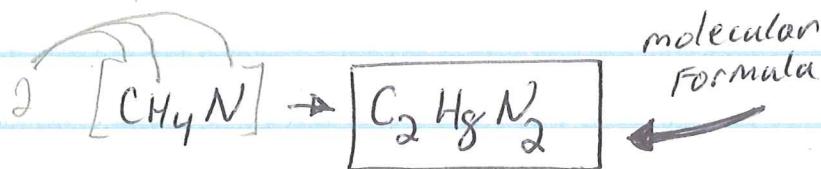
$$12(1) + 1(4) + 1(14) = 12 + 4 + 14 = \underline{30 \text{ g}}$$

(2)

2nd - divide gram formula mass (GFM) by calculated EFM

$$\frac{GFM}{EFM} = \frac{60\text{ g}}{30\text{ g}} = (2)$$

* This means we need to multiply all moles of elements in empirical formula by 2 to get the molecular formula



(caffiene)

ex) what is the Molecular Formula of a compound that is 49.5% C, 5.15% H, 28.9% N, 16.5% O & GFM = 195g

$$\frac{49.5\%}{12.0\text{ g}} \times \frac{1\text{ mol}}{1\text{ mol}} = \frac{4.125}{1.05} (4)$$

C H N O

ratio = 4:5:2:1

$$\frac{5.15\%}{1.0\text{ g}} \times \frac{1\text{ mol}}{1\text{ mol}} = \frac{5.15}{1.05} (5)$$

 $\boxed{C_4H_5N_2O}$

$$\frac{28.9\%}{14.0} \times \frac{1\text{ mol}}{1\text{ mol}} = \frac{2.06}{1.05} (2)$$

empirical

$$\frac{16.5\%}{16.0} \times \frac{1\text{ mol}}{1\text{ mol}} = \frac{1.03}{1.05} (1)$$

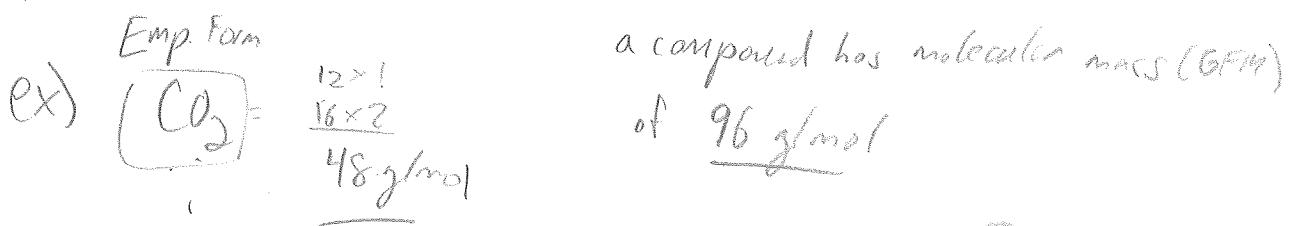
from P.T.

empirical formula = $\boxed{C_4H_5N_2O}$

$$\begin{aligned} EFM &= 12(4) + 1(5) + 14(2) + 16(1) \\ &= 48 + 5 + 28 + 16 = \boxed{97\text{ g}} \end{aligned}$$

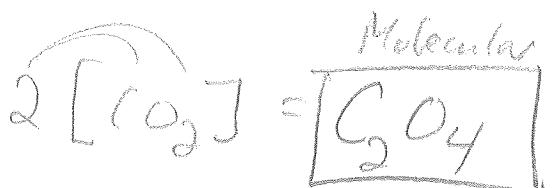
$$M.F. = \frac{195\text{ g (GFM)}}{97\text{ g (EFM)}} = (2)$$

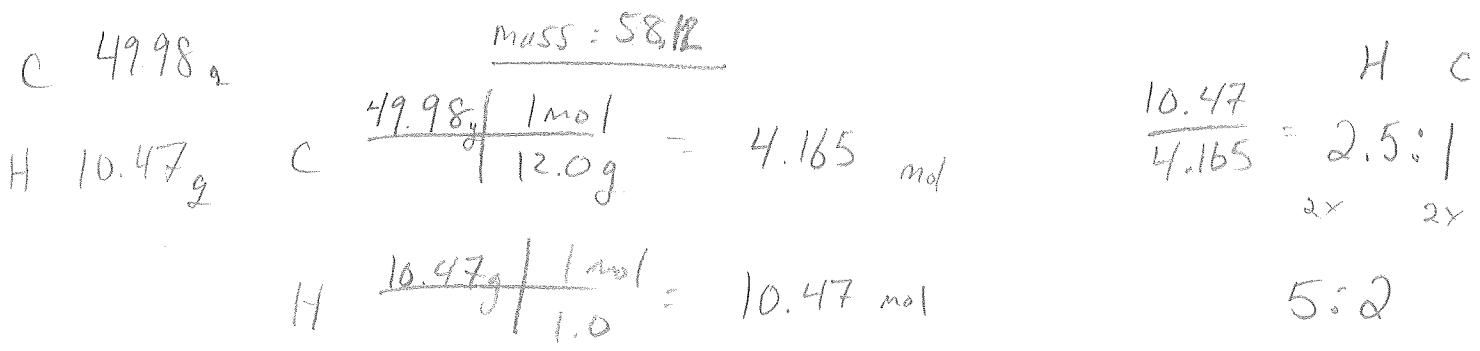
Molecular formula = $\boxed{C_8H_{10}N_4O_2}$



Molecular Formula = ?

$$\frac{96}{48} = \underline{2}$$





Empirical Formula

