Molecular Formula - MF

- The molecular formula - the actual formula for a substance is a multiple of the empirical formula. Once the EF is determined, if you know the molar mass of the molecular formula (MF) it is easy to determine the MF.

Steps

1. Calculate the empirical formula, EF
2. Calculate the molar mass of the EF
3. Divide the molar mass of the MF (given to you in the question) by the molar mass of the EF
4. Multiply the EF by the answer to step 3 to get the MF.

you do NOT need to worry about s.f. here at all!

Examples

1. The empirical formula for a substance was found to be KCO_2 (given). The molar mass of the molecular formula is approximately 166g (given). Determine the molecular formula. (unknown)

step 1 - EF = KCO_2

step 2 - molar mass of KCO_2

$1K \times 39.10g = 39.10g$

$1C \times 12.01g = 12.01g$

$2O \times 16.00g = 32.00g$

$83.11g$

about $83g$

step 3 - $\frac{166g}{83g} = 2$

step 4 - $2(KCO_2)$

MF = $K_2C_2O_4$

2. Analysis of a chemical used in photographic developing fluid shows it is composed of (given) 65.45% C, 5.45% H, and 29.09% O. The molar mass of its molecular formula is approximately 110g. Determine the molecular formula (given / unknown)

Step 1

$$\frac{65.45\text{g C}}{12.01\text{g}} \times \frac{1\text{ mol}}{} = 5.4496\text{ mol C} \Big/ 1.8181\text{ mol} = 2.99 \Rightarrow 3\text{ C}$$

$$\frac{5.45\text{g H}}{1.01\text{g}} \times \frac{1\text{ mol}}{} = 5.3960\text{ mol H} \Big/ 1.8181\text{ mol} = 2.97 \Rightarrow 3\text{ C}$$

$$\frac{29.09\text{g O}}{16.00\text{g}} \times \frac{1\text{ mol}}{} = 1.8181\text{ mol O} \Big/ 1.8181\text{ mol} = 1\text{ O}$$

EF = C_3H_3O

Step 2 - molar mass of C_3H_3O

3 C	× 12.01g =	36.03g
3 H	× 1.01g =	3.03g
1 O	× 16.00g =	+ 16.00g
		55.06g

about 55g

Step 3

$$\frac{110\text{g}}{55\text{g}} = 2$$

Step 4 - $2(C_3H_3O)$

MF = $C_6H_6O_2$

3. Mesitylene, a chemical with a sweet odor is composed of 89.918% C and 10.082% H. Its molecular formula has a molar mass of approximately 121 g. Determine its molecular formula.

given: 89.918% C and 10.082% H; mass of approximately 121 g
unknown: molecular formula

Step 1

$$89.918\text{ g C} \left| \frac{1\text{ mol}}{12.01\text{ g}} \right. = 7.4869\text{ mol C} / 7.4869 = (1\text{ C})3 = 3\text{ C}$$

$$10.082\text{ g H} \left| \frac{1\text{ mol}}{1.01\text{ g}} \right. = 9.9822\text{ mol H} / 7.4869 = (1.33\text{ H})3 = 4\text{ H}$$

EF = C_3H_4

Step 2 - molar mass of C_3H_4

$3\text{ C} \times 12.01\text{ g} = 36.03\text{ g}$

$4\text{ H} \times 1.01\text{ g} = +\ 4.04\text{ g}$

40.07 g

about 40 g

Step 3 $\frac{121\text{ g}}{40\text{ g}} = 3$

Step 4 - $3(C_3H_4)$

MF = C_9H_{12}