Empirical and molecular formulae.

1) An unknown hydrocarbon is found to contain 85.7% carbon and an atomic mass of 84.0 g/mol. What is its molecular formula?

Step 1 mole ratio
=> 85.7 / 12 C : 14.3 / 1 H
=> 7.141 C : 14.3 H
Step 2 Simplest mole ratio
=> 1: 2
=> CH_2
Step 3 Find the number the empirical formula must be multiplied by to get to the molecular formula.
=> x = molecular formula / empirical formula = 84 / 14 = 6

Step 4 Obtain the molecular formula
CH_2 X 6 = C_6H_{12}

2) A 1.50 g sample of a hydrocarbon gas undergoes complete combustion to produce 4.40 g of CO_2 and 1.80 g of H_2O.
a) What is the empirical formula of this compound?
Step 1 Find the mol of hydrogen and carbon atoms present.
=> $n_{Carbon\ dioxide}$ = 4.4 /44 = 0.1 => n_C = 0.1
=> n_{water} = 1.8 / 18 = 0.1 => n_H = 0.20
Step 2 Find the simplest ratios
=> CH_2
b) If its molecular weight has been determined to be 56 g/mol. What is the molecular formula?

Step 1 Find the number the empirical formula must be multiplied by to get to the molecular formula.
=> x = molecular formula / empirical formula = 56 / 14 = 4

Step 2 Obtain the molecular formula
CH_2 X 4 = C_4H_8

c) Write a balanced chemical equation for the combustion reaction.

$C_4H_8(g) + 6O_2(g) => 4CO_2(g) + 4H_2O(g)$

3) An organic compound has the following percent composition: carbon 49.48%, hydrogen 5.19%, oxygen 16.48% and nitrogen 28.85%. Its molecular weight is determined to be around 288 g/mol.

a) What is the empirical formula?
Step 1 mole ratio
=> 49.48 / 12 C : 5.19 / 1 H : 16.48 /16 O : 28.85 / 14 N

=> 4.17 C : 5.19 H : 1.03 O : 2.06

Step 2 Simplest mole ratio

=> 4 C : 5 H : 1 O : 2 N

=> $C_4H_5ON_2$

b) What is its molecular formula?

Step 1 Find the number the empirical formula must be multiplied by to get to the molecular formula.

=> x = molecular formula / empirical formula = 288 / 97 = 3

Step 2 Obtain the molecular formula

$C_{12}H_{15}O_3N_6$

4) What are the empirical and molecular formulae for a compound with 86.88% carbon and 13.12% hydrogen and a molecular weight of about 345 g/mol?

Step 1 mole ratio

=> 86.88 / 12 C : 13.12 / 1 H

=> 7.24 C : 13.12 H

Step 2 Simplest mole ratio

=> 1: 1.8

=> $CH_{1.8}$

Step 3 Multiply by 5 to change the $H_{1.8}$ to a whole number.

=> C_5H_9

Step 4 Find the number the empirical formula must be multiplied by to get to the molecular formula.

=> x = molecular formula / empirical formula = 345 / 69 = 5

Step 4 Obtain the molecular formula

C_5H_9 X 5 = $C_{25}H_4$

5) What are the empirical and molecular formulae for a compound with 83.625% carbon and 16.375% hydrogen and a molecular weight of 388.78?

Step 1 mole ratio

=> 83.625 / 12 C : 16.375 / 1 H

=> 7.0 C : 16.375 H

Step 2 Simplest mole ratio

=> 1 : 2.34

=> $CH_{2.34}$

Step 3 Multiply by 3 to change the $H_{2.34}$ to a whole number.

=> C_3H_7

Step 4 Find the number the empirical formula must be multiplied by to get to the molecular formula.

=> x = molecular formula / empirical formula = 388.78 / 43 = 9.0

Step 4 Obtain the molecular formula
C_3H_7 X 9 = $C_{27}H_{63}$

6) A 3.10 g sample of an unknown organic gas molecule composed of carbon, hydrogen and oxygen, undergoes complete combustion to produce 4.40 g of CO_2 and 2.70 g of H_2O.
a) What is the empirical formula of this compound?

Step 1 Find the mol of hydrogen and carbon atoms present.
=> $n_{Carbon\ dioxide}$ = 4.4 /44 = 0.1 => n_C = 0.1
=> n_{water} = 1.8 / 18 = 0.1 => n_H = 0.30
Step 2 Find the combined mass of carbon and hydrogen in the sample and use it to work out the mass of oxygen present in the sample..
=> 3.10 g = 0.1 X 12 + 0.3 X 1 + x X 16
=> 3.10 g = 1.2 g + 0.3 g + 16x
=> 1.6 = 16x
=> 0.1 = x
=> mol of oxygen present in the sample is 0.1

Step 3 get the mol ratio
=> 0.1 C : 0.3 H : 0.1 O

Step 4 Simplest ratio
CH_3O

b) If its formula mass of about 62 g/mol find its molecular formula?
Step 1 Find the number the empirical formula must be multiplied by to get to the molecular formula.
=> x = molecular formula / empirical formula = 62 / 31 = 2

Step 2 Obtain the molecular formula
CH_3O X 2 = $C_2H_6O_2$