MOLECULAR FORMULAS

A compound of carbon and hydrogen was found to contain 82.66% carbon by mass and have a molecular weight of 58.12 g/mol. What is the molecular formula of this compound?

82.66% C

100.00 g compound

$$82.66\ g\ C\left(\frac{1\ mol\ C}{12.01\ g\ C}\right) = 6.883\ mol\ C$$

$$17.34\ g\ H\left(\frac{1\ mol\ H}{1.008\ g\ H}\right) = 17.20\ mol\ H$$

$$\frac{6.883}{6.883} : \frac{17.20}{6.883} \quad (C : H)$$

$$1 : 2.499$$

$$\downarrow \times 2 \qquad \downarrow \times 2$$

$$2 : 5$$

Empirical Formula: C_2H_5

$$EFW = 2(12.01) + 5(1.008)$$
$$= 24.02 + 5.040$$
$$= 29.06$$

Molecular Formula: $C_{2n}H_{5n}$

n = some integer

$$n = \frac{MWT}{EFW} = \frac{58.12\ g/mol}{29.06\ g/mol} = 2$$

Molecular Formula: C_4H_{10}

58.12 g compound

C: $82.66\%(58.12\,g) =$

$0.8266(58.12\,g) = 48.04\,g\,C$

H: $17.34\%(58.12\,g) =$

$0.1734(58.12\,g) = 10.08\,g\,H$

$48.04\,g\,C\left(\frac{1\,mol\,C}{12.01\,g\,C}\right) = 4\,mol\,C$

$10.08\,g\,H\left(\frac{1\,mol\,H}{1.008\,g\,H}\right) = 10\,mol\,H$

Molecular Formula: C_4H_{10}

Hydrogen combines with oxygen to form water as the sole product of the reaction. What mass of water can be formed if 5.000 g of hydrogen is used in the reaction?

hydrogen + oxygen → water

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

5.000 g excess ? g

$g\,H_2 \rightarrow mol\,H_2 \rightarrow mol\,H_2O \rightarrow g\,H_2O$

$$5.000\,g\,H_2 \left(\frac{1\ mol\,H_2}{2.016\,g\,H_2}\right)\left(\frac{2\ mol\,H_2O}{2\ mol\,H_2}\right)\left(\frac{18.016\,g\,H_2O}{1\ mol\,H_2O}\right)$$

$= 44.68\ g\,H_2O$

What mass of oxygen was consumed in the previous problem?

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$

5.000 g ? g 44.68 g

$$5.000\,g + X = 44.68\,g$$

$$\downarrow$$

$$X = 44.68\,g - 5.000\,g$$

$$= 39.68\,g$$