Mass Percent: Examples

The chlorine in fluorochlorohydrocarbons caused the ozone hole over antarctica. What is the mass % of Cl in CCl_2F_2

$$\text{mass\% Cl} = \frac{(\#\text{ in formula})(\text{atomic mass of element})}{\text{molar mass of compound}}$$

$$M_w(CCl_2F_2) = 12.01\ g/mol + 2 \cdot 35.45\ g/mol + 2 \cdot 19.00\ g/mol$$

$$= 120.91\ g/mol$$

$$\text{mass\% (Cl)} = \frac{2 \cdot 35.45\ g/mol}{120.91\ g/mol} \cdot 100\%$$

$$\text{mass \% (Cl)} = 58.64\%$$

Calculate the mass % of carbon in the antibiotic tetracycline $C_{22}H_{24}N_2O_8$

$$M_w(C_{22}H_{24}N_2O_8) = 22 \cdot 12.01\ g/mol + 24 \cdot 1.008\ g/mol + 2 \cdot 14.01\ g/mol + 8 \cdot 16.00\ g/mol$$

$$= 444.4\ g/mol$$

$$\text{mass \% (C)} = \frac{22 \cdot 12.01\ g/mol}{444.4\ g/mol} \cdot 100\%$$

$$= 59.46\ \%$$

Empirical Formula

A compound containing nitrogen and oxygen is decomposed in the laboratory and produces 24.5 g nitrogen and 70.0 g oxygen. Calculate the empirical formula of the compound.

1. Given: 24.5 g N ; 70.0 g O
2. Convert each of the masses to moles

$$\#\ moles\ (N) = 24.5\ g \cdot \frac{1\ mol}{14.01\ g} = 1.75\ mol$$

$$\#\ moles\ (O) = 70.0\ g \cdot \frac{1\ mol}{16\ g} = 4.38\ mol$$

3. Write down a pseudo formula:

$N_{1.75}O_{4.38}$

4. Divide all subscripts in the formula by the smallest subscript

$$N_{\frac{1.75}{1.75}}O_{\frac{4.38}{1.75}} \rightarrow N_1O_{2.5}$$

5. If the subscripts are not whole numbers, multiply all the subscripts by a small whole number to get whole number subscripts

$N_1O_{2.5} \times 2 \Rightarrow N_2O_5$

A laboratory analysis of aspirin determined the following mass percent composition:

C : 60.00 %
H : 4.48 %
O : 35.52 %

Find the empirical formula!

1. Given:

Assume 100 g total => % = grams

=> 60.00 g C ; 4.48 g H ; 35.52 g O

2. Convert masses → moles

$\#\text{moles "C"} = 60.00\,g \cdot \frac{1\,mol}{12.01\,g} = 4.996\,mol$

$\#\text{moles "H"} = 4.48\,g \cdot \frac{1\,mol}{1.008\,g} = 4.44\,mol$

$\#\text{moles "O"} = 35.52\,g \cdot \frac{1\,mol}{16.00\,g} = 2.220\,mol$

3. Write pseudo formula

$C_{4.996}H_{4.44}O_{2.220}$

4. Divide by smallest subscript

$$\frac{C_{4.996}}{2.220}\ \frac{H_{4.440}}{2.220}\ \frac{O_{2.220}}{2.220} \Rightarrow C_{2.25}H_2O_1$$

5. Multiply with whole number to clear fraction :

$$C_{2.25}H_2O_1 \times \frac{4}{=} \Rightarrow C_9H_8O_4$$