Percent Composition by Mass

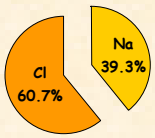
Percent Composition may be just a "fraction" of chemistry, but it all weighs up to 100%!

definition…definition…definition…definition

Percent Composition – is the percent by mass of each element in the compound.

Example: The percent composition of NaCl is:

Na = 39.3%
Cl = 60.7%



The percents of all the elements in a compound must total 100%!

So, why isn't the percent composition of NaCl 50/50?

~~Na = 50%~~
~~Cl = 50%~~

The percent composition is based on the % mass of each element, *not* on the % number of each element.

Lets work out the % composition of NaCl together!

To Calculate Percent Composition:

1. *Calculate the molar mass of the compound, then*
2. *Identify the total mass of each element present.*
3. *Divide the element mass by the compound molar mass.*

…formula… formula … formula … formula … formula …

$$\% \text{ mass} = \frac{\text{grams of element}}{\text{compound molar mass}} \times 100$$

Example 1: Calculate the percent by weight of sodium and chlorine in NaCl.

Step 1: Calculate the molar mass of NaCl:

Na: 1 x 23.0 g = 23.0 g
Cl: 1 x 35.5 g = +35.5 g

molar mass of NaCl = 58.5 g

...Can you dig it?

Remember always round molar mass to one place after the decimal!

Step 2 - Calculate the % mass for each element:

Sodium:

- Calculate the mass of just Na: 23.0 g
- Calculate the % mass of Na in NaCl:

$$\% \text{ Na} = \frac{23.0 \text{ g}}{58.5 \text{ g}} \times 100$$

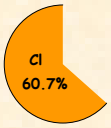
% Na = 39.3%

Chlorine:

- Calculate the mass of just Cl: 35.5 g
- Calculate the % mass of Cl in NaCl:

$$\% \text{ Cl} = \frac{35.5 \text{ g}}{58.5 \text{ g}} \times 100$$

% Cl = 60.7%



Example problem #2:

Find the percent composition of NH_4NO_3:

N = ???%
H = ???%
O = ???%

These percents must total 100%!

Remember… we will use this equation:

$$\% \text{ mass} = \frac{\text{grams of element}}{\text{compound molar mass}} \times 100$$

Step 1 - Calculate the molar mass of NH_4NO_3

N: 2 mol x 14.0 g = 28.0 g
H: 4 mol x 1.0 g = 4.0 g
O: 3 mol x 16.0 g = + 48.0 g

molar mass of NH_4NO_3 = 80.0 g

Step 2 - Calculate the % mass for each element:

Remember, $\% \text{ mass} = \frac{\text{grams of element}}{\text{compound molar mass}} \times 100$

$$\% \text{ N in } NH_4NO_3 = \frac{28.0 \text{ g}}{80.0 \text{ g}} \times 100$$

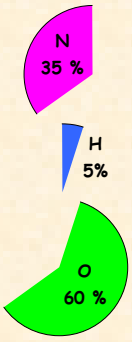
% N in NH_4NO_3 = 35.0%

$$\% \text{ H in } NH_4NO_3 = \frac{4.0 \text{ g}}{80.0 \text{ g}} \times 100$$

% H in NH_4NO_3 = 5.0%

$$\% \text{ O in } NH_4NO_3 = \frac{48.0 \text{ g}}{80.0 \text{ g}} \times 100$$

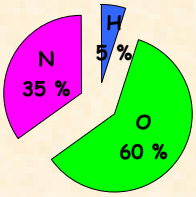
% O in NH_4NO_3 = 60.0%



Double check you're answer ---

Add them all together, what have you got?

100% !!



Example problem #3:

Find the % composition of the compound that is formed from 8.2 g Mg and 5.4 g of O_2:

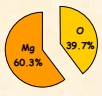
Step 1: Find the mass of the whole compound.

8.2 g Mg + 5.4 g O_2 = 13.6 g MgO

Step 2: Find the % of each element in the compound.

$$\% \text{ Mg} = \frac{8.2 \text{ g}}{13.6 \text{ g}} \times 100 = 60.3\ \%$$

$$\% \text{ O} = \frac{5.4 \text{ g}}{13.6 \text{ g}} \times 100 = 39.7\ \%$$



Example problem #4:

Calculate the mass of hydrogen in 20.2 g of potassium hydroxide. KOH

Step 1: Find the molar mass of KOH.

K: 1 x 39.1 = 39.1
O: 1 x 16.0 = 16.0
H: 1 x 1.0 = 1.0
= 56.1 g

Step 2: Use dimensional analysis to solve.

$$20.2 \text{ g KOH} \left| \frac{1.0 \text{ g H}}{56.1 \text{ g KOH}} \right. = 0.36 \text{ g H}$$

Example problem #5:

Calculate the mass of hydrogen in 20.2 g of ethane. C_2H_6

Step 1: Find the molar mass of C_2H_6.

C: 2 x 12.0 = 24.0

H: 6 x 1.0 = 6.0

= 30.0

Step 2: Use dimensional analysis to solve.

$$20.2\ g\ C_2H_6 \times \frac{6.0\ g\ H}{30.0\ g\ C_2H_6} = 4.0\ g\ H$$

Warm-up problem #1:

Calculate the % nitrogen in ammonium cyanide: NH_4CN

Step 1: Find the mass of the whole compound.

(2 x 14.0 g) + (4 x 1.0 g) + (1 x 12.0 g) = 44.0 g

Step 2: Find the % N in the compound.

$$\%\ N = \frac{28.0\ g}{44.0\ g} \times 100 = 63.6\ \%$$

Example problem #3: alternative solution

Calculate the mass of hydrogen in 20.2 g of potassium hydroxide. KOH

Step 1: Find the % H in potassium hydroxide.

KOH = 39.1 + 16.0 + 1.0 = 56.1 g

$$\%\ H = \frac{1.0\ g}{56.1\ g} \times 100 = 1.8\ \%$$

Step 2: Use dimensional analysis to solve.

$$20.2\ g\ KOH \times \frac{1.8\ g\ H}{100\ g\ KOH} = 3.6 \times 10^{-1}\ g\ H$$

% of an element = grams of the element

Total grams