

Percent Composition (Percentage Composition)

The percent composition (percentage composition) of a compound is a relative measure of the mass of each different element present in the compound.

To calculate the percent composition (percentage composition) of a compound

- Calculate the molecular mass (molecular weight, formula mass, formula weight), MM, of the compound
- Calculate the total mass of each element present in the formula of the compound
- Calculate the percent composition (percentage composition):
% by weight (mass) of element = (total mass of element present ÷ molecular mass) x 100

Example 1

Calculate the percent by weight of sodium (Na) and chlorine (Cl) in sodium chloride (NaCl)

- Calculate the molecular mass (MM):
 $MM = 22.99 + 35.45 = 58.44$
- Calculate the total mass of Na present:
1 Na is present in the formula, mass = 22.99
- Calculate the percent by weight of Na in NaCl:
%Na = (mass Na ÷ MM) x 100 = (22.99 ÷ 58.44) x 100 = **39.34%**
- Calculate the total mass of Cl present:
1 Cl is present in the formula, mass = 35.45
- Calculate the percent by weight of Cl in NaCl:
%Cl = (mass Cl ÷ MM) x 100 = (35.45 ÷ 58.44) x 100 = **60.66%**

The answers above are probably correct if %Na + %Cl = 100, that is, 39.34 + 60.66 = 100.

Example 2

Calculate the percent by weight of each element present in sodium sulfate (Na_2SO_4).

- Calculate the molecular mass (MM):
 $\text{MM} = (2 \times 22.99) + 32.06 + (4 \times 16.00) = 142.04$
- Calculate the total mass of Na present:
2 Na are present in the formula, mass = $2 \times 22.99 = 45.98$
- Calculate the percent by weight of Na in Na_2SO_4 :
%Na = $(\text{mass Na} \div \text{MM}) \times 100 = (45.98 \div 142.04) \times 100 =$
32.37%
- Calculate the total mass of S present in Na_2SO_4 :
1 S is present in the formula, mass = 32.06
- Calculate the percent by weight of S present:
%S = $(\text{mass S} \div \text{MM}) \times 100 = (32.06 \div 142.04) \times 100 =$
22.57%
- Calculate the total mass of O present in Na_2SO_4 :
4 O are present in the formula, mass = $4 \times 16.00 = 64.00$
- Calculate the percent by weight of O in Na_2SO_4 :
%O = $(\text{mass O} \div \text{MM}) \times 100 = (64.00 \div 142.04) \times 100 =$
45.06%

The answers above are probably correct if $\% \text{Na} + \% \text{S} + \% \text{O} = 100$,
that is,

$$32.37 + 22.57 + 45.06 = 100$$

Example 3

Calculate the percent by weight of each element present in ammonium phosphate $[(\text{NH}_4)_3\text{PO}_4]$

- Calculate the molecular mass (MM) of $(\text{NH}_4)_3\text{PO}_4$:
 $\text{MM} = 3 \times [14.01 + (4 \times 1.008)] + 30.97 + (4 \times 16.00) = 3 \times [14.01 + 4.032] + 30.97 + 64.00 = (3 \times 18.042) + 30.97 + 64.00 = 54.126 + 30.97 + 64.00 = 149.096$
- Calculate the total mass of N present:
3 N are present, mass = $3 \times 14.01 = 42.03$
- Calculate the percent by mass of N present in $(\text{NH}_4)_3\text{PO}_4$:
%N = $(\text{mass N} \div \text{MM}) \times 100 = (42.03 \div 149.096) \times 100 =$
28.19%
- Calculate the total mass of H present:
12 H are present in the formula, mass = $12 \times 1.008 = 12.096$
- Calculate the percent by mass of H present in $(\text{NH}_4)_3\text{PO}_4$:
%H = $(\text{mass H} \div \text{MM}) \times 100 = (12.096 \div 149.096) \times 100 =$
8.11%
- Calculate the total mass of P present:
1 P is present in the formula, mass = 30.97
- Calculate the percent by mass P in $(\text{NH}_4)_3\text{PO}_4$:
%P = $(\text{mass P} \div \text{MM}) \times 100 = (30.97 \div 149.096) \times 100 =$
20.77%
- Calculate the total mass of O present:
4 O are present in the formula, mass = $4 \times 16.00 = 64.00$
- Calculate the percent by mass of O in $(\text{NH}_4)_3\text{PO}_4$:
%O = $(\text{mass O} \div \text{MM}) \times 100 = (64.00 \div 149.096) \times 100 =$
42.93%

The answers above are probably correct if $\%N + \%H + \%P + \%O = 100$, that is,

$$28.19 + 8.11 + 20.77 + 42.93 = 100$$

Percentage Compositions to try

1. Find the % composition of the following;

Methane CH_4

Glucose $\text{C}_6\text{H}_{12}\text{O}_6$

Ethanol $\text{C}_2\text{H}_5\text{OH}$

Q2 Chemical fertilizers usually contain nitrogen. Which of the following would provide the greatest % of N?

- a. ammonium chloride, ammonium sulphate, ammonium nitrate or ammonia**

Q3 Calculate the % water present in the following;

Barium chloride dehydrate

Magnesium sulphate heptahydrate

Copper sulphate pentahydrate

Washing soda, sodium carbonate decahydrate

EXTRA look up the meaning of the following words, **hygroscopic, efflorescence and deliquescence.**