

Percentage Composition by Mass



Can you figure out which fertilizer is best?



My uncle uses fertilizers on his garden to grow his prize-winning pumpkins.

How can he tell which fertilizer contains the most nitrogen?

Different fertilizers contain different compounds. Your uncle needs to find out the **percentage by mass** of nitrogen in each compound.



How is percentage by mass calculated?



Scientists use **percentage by mass** calculations to help them figure out how useful a substance is, how pure it is or even to identify an unknown substance.

The percentage by mass of an element in a compound is sometimes known as the **percentage composition**. Percentage by mass is calculated using r.a.m. and r.f.m.

$$\% \text{ element} = \frac{\text{r.a.m. of element} \times \text{number of atoms}}{\text{r.f.m of compound}} \times 100$$

Calculating percentage by mass – example 1

What percentage by mass of **nitrogen** is in ammonia (**NH₃**)?
(r.a.m.: H = 1, N = 14)

Step 1: Find the relative formula mass (r.f.m.) of NH₃.

$$\begin{aligned}\text{r.f.m. of NH}_3 &= 1 \text{ nitrogen atom} + 3 \text{ hydrogen atoms} \\ &= (1 \times 14) + (3 \times 1) \\ &= 17\end{aligned}$$

Step 2: Find the percentage by mass of nitrogen.

$$\begin{aligned}\% \text{ of nitrogen in NH}_3 &= \frac{\text{r.a.m.} \times \text{number of atoms}}{\text{r.f.m. of compound}} \times 100 \\ &= \frac{(14 \times 1)}{17} \times 100 \\ &= \mathbf{82\%}\end{aligned}$$

Calculating percentage by mass – example 2

What percentage by mass of **hydrogen** is in ammonia (NH_3)?
(r.a.m.: H = 1, N = 14)

Step 1: Find the relative formula mass (r.f.m.) of NH_3 .

$$\begin{aligned}\text{r.f.m. of NH}_3 &= 1 \text{ nitrogen atom} + 3 \text{ hydrogen atoms} \\ &= (1 \times 14) + (3 \times 1) \\ &= 17\end{aligned}$$

Step 2: Find the percentage by mass of hydrogen.

$$\begin{aligned}\% \text{ of hydrogen in NH}_3 &= \frac{\text{r.a.m.} \times \text{number of atoms}}{\text{r.f.m. of compound}} \times 100 \\ &= \frac{(1 \times 3)}{17} \times 100 \\ &= \mathbf{18\%}\end{aligned}$$

How much oxygen?



What is the percentage by mass of oxygen
in each compound?

Compound	Relative formula mass	% of oxygen
MgO	?	?
K ₂ O	?	?
NaOH	?	?
SO ₂	?	?



How much nitrogen does each fertilizer contain?



My uncle still can't decide which fertilizer to buy. There are three to choose from, each containing a different source of nitrogen.

What is the percentage of nitrogen in each one?

?

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Comparing fertilizers



Which fertilizer is the best?

Fertilizer	Compound	% nitrogen
MEGA pumpkin	NH_4NO_3	35%
Supergro	$(\text{NH}_4)_2\text{SO}_4$	21%
Plant-B-big	CON_2H_4	47%



'Plant-B-big', which contains urea, has the highest percentage of nitrogen.

So, if my uncle puts the same amount of each fertilizer on his pumpkins, 'Plant-B-big' will provide the most nitrogen.