

AIM | What is formula weight?

11

Every compound has a formula. For example, H_2O is the formula for water. $NaCl$ is the formula for table salt. $C_{12}H_{22}O_{11}$ is the formula for table sugar.

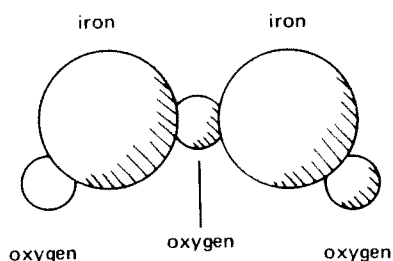
Compounds are made of atoms. Atoms have weight. Therefore, compounds have weight.

If we add the weight of all the atoms in a compound, we find the weight of one molecule of that compound.

The weight of one molecule of a compound is called its *formula weight*. It is also called its *molecular weight*.

Let's look at an example.

How to find the formula weight of ferric oxide (Fe_2O_3):



One molecule of ferric oxide (Fe_2O_3) has 2 atoms of iron and 3 atoms of oxygen.

Element	Number of atoms		Atomic weight rounded off (Weight of one atom)	Total weight of atoms
Iron	2	×	56	112
Oxygen	3	×	16	<u>48</u>
				160 =
				FORMULA WEIGHT (Weight of one molecule of Fe_2O_3)

WORKING WITH FORMULA WEIGHTS

Find the formula (molecular) weight of each compound that follows. Look up the symbol names and atomic weights. (You probably know the names of most of these symbols.)

1. Sulfuric acid H_2SO_4

Element	Number of atoms	Atomic weight	Total weight of atoms
Hydrogen	2	×	
Sulfur	1	×	
Oxygen	4	×	

Chart I

Formula weight = _____

2. Sucrose (table sugar) $C_{12}H_{22}O_{11}$

Element	Number of atoms	Atomic weight	Total weight of atoms

Chart II

Formula weight = _____

3. Sodium bicarbonate (baking soda) $NaHCO_3$

Element	Number of atoms	Atomic weight	Total weight of atoms

Chart III

Formula weight = _____

THE INSIDE STORY

Now let's try slightly more difficult compounds. (You will find that they aren't really more difficult.)

How do you handle a compound where part of the compound is in *parentheses* and this part is followed by a *subscript*? $\text{Ca}(\text{NO}_3)_2$ (calcium nitrate) is an example.

Step 1 Find the number of atoms of each element.



The calcium, Ca , is outside the parentheses. No special figuring is needed.

The nitrate $(\text{NO}_3)_2$ needs some very easy figuring.

This formula has one atom of calcium.

Simply multiply the number of atoms of each element within the parentheses by the subscript (2).

$\text{Ca} = 1$ atom

So we have

Subscript

$$\text{N} = 1 \times 2 = 2 \text{ atoms}$$

$$\text{O} = 3 \times 2 = 6 \text{ atoms}$$

Step 2 Now we can find the formula weight.

Element	Number of atoms	Atomic weight	Total weight of atoms
Calcium	1	40	40
Nitrogen	2	14	28
Oxygen	6	16	96

Chart IV

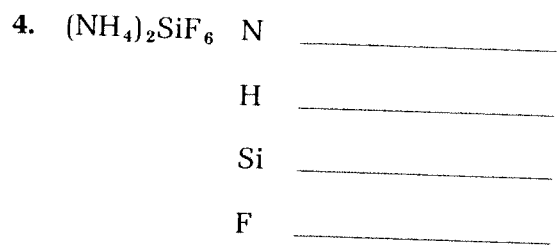
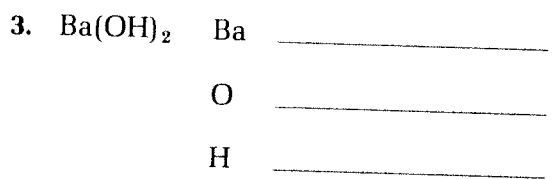
164
Formula Weight of
one molecule of $\text{Ca}(\text{NO}_3)_2$

WORKING WITH COMPOUNDS WITH PARENTHESES

Four formulas are given. Figure out the number of atoms of each element.

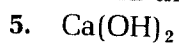
1. $\text{Fe}(\text{NO}_3)_2$ Fe _____
N _____
O _____

2. $\text{Al}_2(\text{SO}_4)_3$ Al _____
S _____
O _____



Now that you know how to handle parentheses and subscripts, figure out the formula weight of each formula listed below.

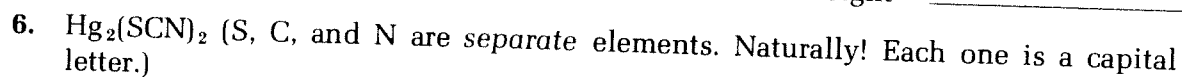
Find the names of the elements in the Periodic Table (pages 168–169).



Element	Number of atoms	Atomic weight	Total weight of atoms
Calcium	1		
Oxygen	2		
Hydrogen	2		

Chart V

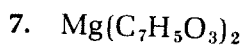
Formula Weight = _____



Element	Number of atoms	Atomic weight	Total weight of atoms

Chart VI

Formula weight = _____



Element	Number of atoms	Atomic weight	Total weight of atoms

Chart VII

Formula weight = _____

WHAT DOES THE LARGE NUMBER MEAN?

Sometimes you see a compound or a symbol that has a large number in front of it. What does this mean?

What does the 2 mean in 2Na or 2NaCl? What does the 3 mean in 3H₂?

The large number tells you to *multiply* each kind of atom by that number. Let's look at some examples:



2 Na means 2 atoms of sodium.



2NaCl means two molecules of NaCl. That means two atoms of sodium and two atoms of chlorine.

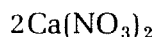


Here we must *multiply* the 3×2 . There are 6 atoms of hydrogen.



There are still 6 atoms of hydrogen. But we also have oxygen. $3 \times 1 = 3$ atoms of oxygen.

Now let's see how to handle a compound that has both parentheses and a large number.



The 2 means two molecules of Ca(NO₃)₂.

How many atoms of each element does this mean? We must multiply the number of each kind of atom by 2.

Ca $1 \times 2 = 2$ atoms

N $1 \times 2 \times 2 = 4$ atoms

from parentheses

from large number

O $3 \times 2 \times 2 = 12$ atoms

An important thing to remember!

A large number in front of an element or a compound goes *only* with that element or compound. A plus sign (+) or an arrow \rightarrow tells us where the value of the large number ends. For example:



- The 4 in front of the Fe goes only with the Fe.
- The 3 in front of the O₂ goes only with the O₂.
- But the 2 in front of Fe₂O₃ goes with the Fe₂ and the O₃. They are part of the same molecule.

LET'S JUST COUNT

Count the number of atoms in each of the following:

- | | | | |
|------------------------------|----------|---|----------|
| 1. $2\text{Ba}(\text{OH})_2$ | Ba _____ | 2. $4\text{Al}_2(\text{SO}_4)_3$ | Al _____ |
| | O _____ | | S _____ |
| | H _____ | | O _____ |
| 3. $3\text{Ba}(\text{OH})_2$ | Ba _____ | 4. $2\text{Mg}(\text{C}_7\text{H}_5\text{O}_3)_2$ | Mg _____ |
| | O _____ | | C _____ |
| | H _____ | | H _____ |
| | | | O _____ |

NOW BACK TO WEIGHTS

Now you know how to handle formulas that have both parentheses and large numbers in front. How do we figure weights for these formulas?

Simple! On page 66 you learned that the formula weight of $\text{Ca}(\text{NO}_3)_2$ is 164. This means that one molecule weighs 164.

What is the weight of $2\text{Ca}(\text{NO}_3)_2$? Easy! Just multiply the formula weight by 2.

$$\text{Weight of } 2\text{Ca}(\text{NO}_3)_2: 2 \times 164 = 328$$

formula weight

The formula weight of $\text{Ba}(\text{OH})_2$ is 171.

Figure the weight of each of the following:

- | | |
|------------------------------------|------------------------------------|
| 1. $2\text{Ba}(\text{OH})_2$ _____ | 2. $3\text{Ba}(\text{OH})_2$ _____ |
|------------------------------------|------------------------------------|

The formula weight of $\text{Pb}(\text{NO}_3)_2$ is 331.

Figure the weight of each of the following:

- | | |
|--------------------------------------|--------------------------------------|
| 3. $2\text{Pb}(\text{NO}_3)_2$ _____ | 4. $4\text{Pb}(\text{NO}_3)_2$ _____ |
|--------------------------------------|--------------------------------------|

REACHING OUT

1. Find the formula weight of this compound: $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$.

2. Find the weight of the following: $2\text{Al}_2(\text{SO}_3)_3$

FIND THE DATE Use your knowledge of atomic weights and simple math to find an important date in history.

Step 1 Find the weight of 4 atoms of platinum (Pt).

Step 2 Find the weight of 3 atoms of uranium (U).

Step 3 Add Steps 1 and 2.

Step 4 Find the weight of 2 atoms of hydrogen (H).

Step 5 Subtract Step 4 from Step 3.

What event took place during the year you have written for Step 5?
