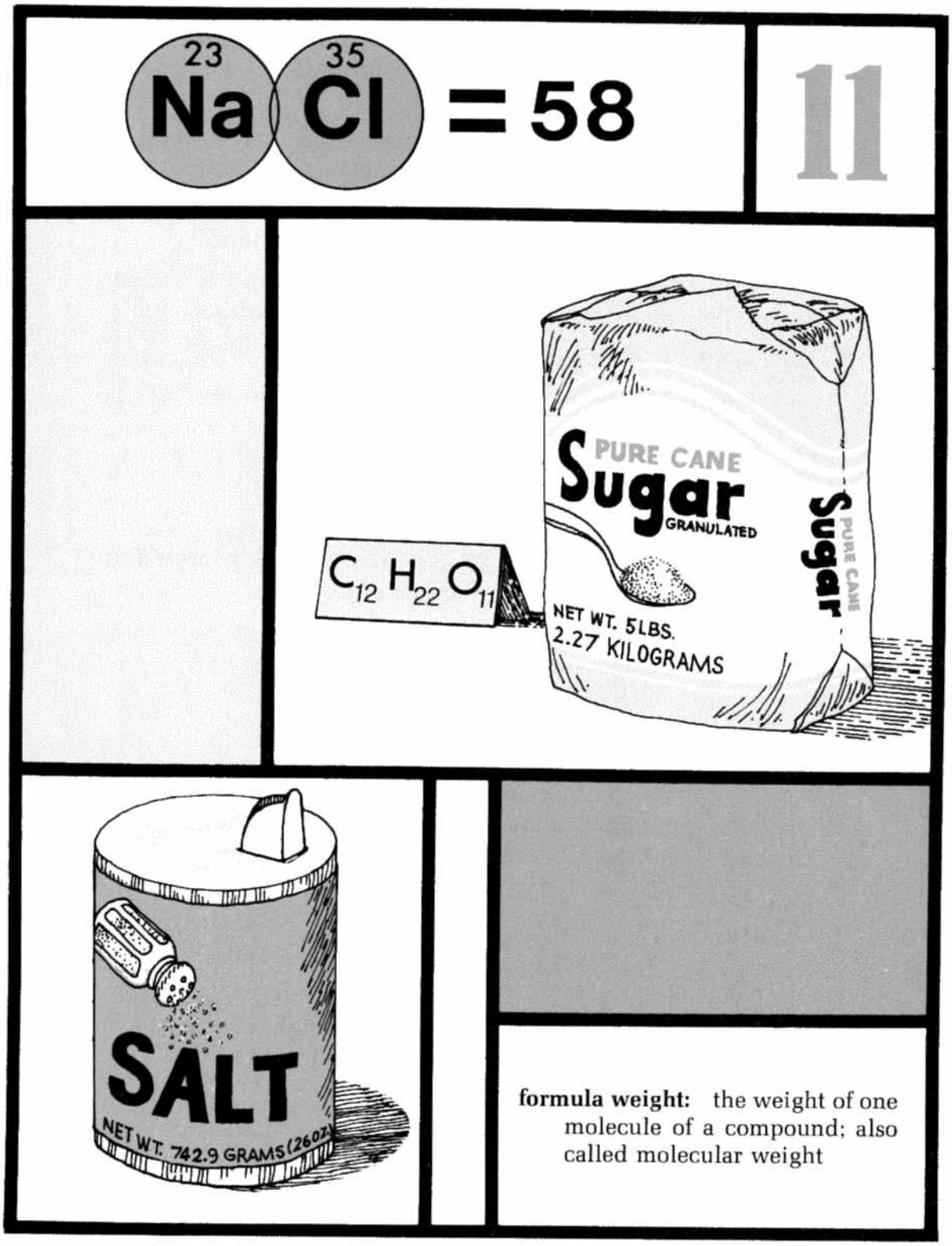
WHAT IS FORMULA WEIGHT?



formula weight: the weight of one molecule of a compound; also called molecular weight

AIM 11 | What is formula weight?

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.

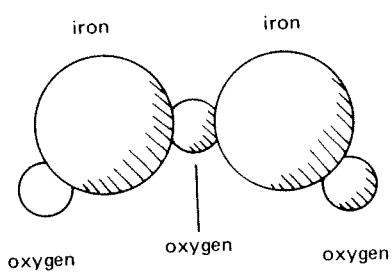
Compounds are made of atoms. Atoms have weight. Therefore, compounds have weight.

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	48
			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*? $Ca(NO_3)_2$ (calcium nitrate) is an example.

Step 1 Find the number of atoms of each element.

$$Ca(NO_3)_2$$

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

This formula has *one atom of calcium.*

Ca = 1 atom

The nitrate $(NO_3)_2$ needs some very easy figuring.

Simply multiply the number of atoms of each element *within* the parentheses by the subscript ($_2$).

So we have

Subscript

N = 1 × 2 = 2 atoms
O = 3 × 2 = 6 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
			164

Chart IV

Formula Weight of one molecule of $Ca(NO_3)_2$

WORKING WITH COMPOUNDS WITH PARENTHESES

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

1. $Fe(NO_3)_2$ Fe _____

N _____

O _____

2. $Al_2(SO_4)_3$ Al _____

S _____

O _____

3. $Ba(OH)_2$ Ba _____

O _____

H _____

4. $(NH_4)_2SiF_6$ N _____

H _____

Si _____

F _____

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).

5. $Ca(OH)_2$

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

Chart V

Formula Weight = _____

6. $Hg_2(SCN)_2$ (S, C, and N are *separate* elements. Naturally! Each one is a capital letter.)

Element	Number of atoms	Atomic weight	Total weight of atoms

Chart VI

Formula weight = _____

7. $Mg(C_7H_5O_3)_2$

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 $3H_2$?

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

2Na	2 Na means 2 atoms of sodium.
2NaCl	2NaCl means two molecules of NaCl. That means two atoms of sodium and two atoms of chlorine.
$3H_2$	Here we must *multiply* the **3** × 2. There are 6 atoms of hydrogen.
$3H_2O$	There are still 6 atoms of hydrogen. But we also have oxygen. **3** × 1 = 3 atoms of oxygen.

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

$2Ca(NO_3)_2$	The **2** means two molecules of $Ca(NO_3)_2$.

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

Ca 1 × **2** = 2 atoms

N 1 × 2 × 2 = 4 atoms

from parentheses | from large number

O 3 × 2 × 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 → tells us where the value of the large number ends. For example:

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

- The 4 in front of the Fe goes only with the Fe.
- The 3 in front of the O_2 goes only with the O_2.
- But the 2 in front of Fe_2O_3 goes with the Fe_2 and the O_3. They are part of the same molecule.

LET'S JUST COUNT

Count the number of atoms in each of the following:

1. $2Ba(OH)_2$ Ba _____

O _____

H _____

2. $4Al_2(SO_4)_3$ Al _____

S _____

O _____

3. $3Ba(OH)_2$ Ba _____

O _____

H _____

4. $2Mg(C_7H_5O_3)_2$ Mg _____

C _____

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 $Ca(NO_3)_2$ is 164. This means that one molecule weighs 164.

What is the weight of $2Ca(NO_3)_2$? Easy! Just multiply the formula weight by 2.

Weight of $2Ca(NO_3)_2$: $2 \times 164 =$ 328
formula weight

The formula weight of $Ba(OH)_2$ is 171.

Figure the weight of each of the following:

1. $2Ba(OH)_2$ _____

2. $3Ba(OH)_2$ _____

The formula weight of $Pb(NO_3)_2$ is 331.

Figure the weight of each of the following:

3. $2Pb(NO_3)_2$ _____

4. $4Pb(NO_3)_2$ _____

REACHING OUT

1. Find the formula weight of this compound: $Fe(NH_4)_2(SO_4)_2$.

_____

2. Find the weight of the following: $2Al_2(SO_3)_3$

_____

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? _____

_____