Molecular Weight

The molecular weight of a substance is the weight in atomic mass units of all the atoms in a given formula.

An atomic mass unit is defined as 1/12 the weight of the carbon-12 isotope. The old symbol was amu, while the most correct symbol is u (a lower case letter u). The ChemTeam will use amu.

By the way, carbon-12 is defined as weighing exactly 12 amu. This is the starting point for how much an atom weighs. For example, if you weigh 1/2 as much as C-12, you weigh 6. If you weigh twice as much, you weigh 24.

The molecular weight of a substance is needed to tell us how many grams are in one mole of that substance.

The mole is the standard method in chemistry for communicating how much of a substance is present.

You should have a periodic table for looking up atomic weights and a calculator.

Point #1 - You need to know how many atoms of each element are in a substance in order to calculate its molecular weight.

For example H_2O has two atoms of hydrogen and one atom of oxygen. H_2O_2 has two atoms each of oxygen and hydrogen. $Mg(OH)_2$ has one atom of magnesiun and two each of oxygen and hydrogen.

If a subscript follows an atom with no parenthesis, that number tells you how many of that atom are present. If parentheses are involved, you must multiply each subscript inside by the one which is outside.

How many of each element are in the following examples (answers just below the problems, so scroll carefully):

KCl

Fe_2O_3

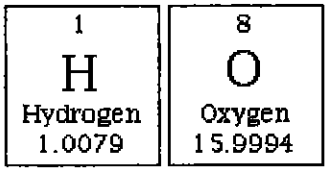
$Al(NO_3)_3$

NH_4NO_3

$Al_2(SO_4)_3$

Point#2 - You need to know the atomic weight of each element in order to calculate the molecular weight of the substance.

The atomic weight of each element is found by examining the periodic table. Just below are typical entries in the periodic table for hydrogen and oxygen.



The important number right now is at the bottom of each box. For hydrogen the number is 1.0079 and for oxygen it is 15.9994. These numbers are the atomic weight for each element.

The atomic weights in your periodic table may be slightly different than the ChemTeam's. This is usually due to rounding off by the publisher. Also, atomic weight values are periodically redetermined and refined and this may contribute to minor differences in the weights used. There are lots of periodic table web sites. This sentence is a link to Yahoo's list of periodic tables.

How to calculate the molecular weight of a substance

Here's how: multiply each element's atomic weight by how many atoms are present in the formula, then add the answers.

Example #1 - $Al_2(SO_4)_3$

There are:

- two atoms of aluminum and the atomic weight of Al is 26.98 amu.
- three atoms of sulfur and the atomic weight of S is 32.06 amu.
- twelve atoms of oxygen and the atomic weight of O is 16.00 amu.

First multiply:

2 x 26.98 = 53.96 total weight of all Al in formula

3 x 32.06 = 96.18 total weight of all S in formula

12 x 16.00 = 192.00 total weight of all O in formula

Then add: 53.96 + 96.18 + 192.00 = 342.14 amu.

This answer, 342.14 amu, represents the molecular weight of $Al_2(SO_4)_3$

You might be asking why I used oxygen at 16.00 and not 15.9994. Actually, you could use the more exact value, but then when rounding off your answer, you would get back to the 342.14 value.

Example #2 - H_2O_2

Hydrogen: two atoms, atomic weight = 1.0079 amu

Oxygen: two atoms, atomic weight = 15.9994 amu

(2 x 1.0079) + (2 x 15.9994) = 34.0146

Review
four steps to calculating a substance's molecular weight

Step One: Determine how many atoms of each different element are in the formula.

Step Two: Look up the atomic weight of each element in a periodic table.

Step Three: Multiply step one times step two for each element.

Step Four: Add the results of step three together and round off as necessary.

Special Note about Hydrates

Suppose you were asked to calculate the molecular weight of $CuSO_4 \cdot 5H_2O$

Remember that the dot DOES NOT mean multiply.

You could approach this two ways:

1. Add the atomic weights of one copper, one sulfur, nine oxygens, and ten hydrogens.
2. Add the atomic weights of one copper, one sulfur, and four oxygens. Then add the molecular weight of five H_2O molecules.

The answer is 249.68 amu.

Calculate the molecular weight of:

1) $(NH_4)_2S$

2) Fe_2O_3

3) $KClO_4$

4) SF_6

5) $(NH_4)_2SO_4$