Avogadro Number Calculations II Std 3c

How Many Atoms or Molecules?

The value for Avogadro's Number is 6.022×10^{23} mol^{-1}.

Types of problems you might be asked look something like these:

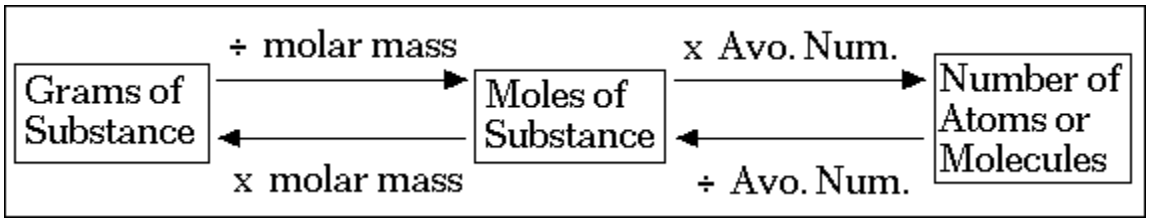
1. 0.450 mole (or gram) of Fe contains how many atoms?
2. 0.200 mole (or gram) of H_2O contains how many molecules?

When the word gram replaces mole, you have a related set of problems which requires one more step. So keep in mind that there are 4 example problems just above.

1. Calculate the number of molecules in 1.058 mole (or gram) of H_2O
2. Calculate the number of atoms in 0.750 mole (or gram) of Fe

These problems use the reverse technique of the above. Once again, replacing mole with gram adds one step to the procedure.

Here is a graphic of the procedure steps:



Pick the box of the data you are given in the problem and follow the steps toward the box containing what you are asked for in the problem.

Example #1: 0.450 mole of Fe contains how many atoms?

Solution: start from the box labeled "mole" and move (to the right) to the box labeled "atoms." What do you have to do to get there? That's right - multiply by Avogadro's Number.

$$0.450 \text{ mol} \times 6.022 \times 10^{23} \text{ mol}^{-1}$$

Example #2: 0.200 mole of H_2O contains how many molecules?

Solution:

$$0.200 \text{ mol} \times 6.022 \times 10^{23} \text{ mol}^{-1}$$

The answers (including units) to the above two problems

The unit on Avogadro's Number might look a bit weird. It is mol^{-1} and you would say "per mole" out loud. The question then is **WHAT** per mole?

The answer is it depends on the problem. In the first example, I used iron, an element. Almost all elements come in the form of individual atoms, so the correct numerator with most elements is "atoms." (I will leave you to figure out the exceptions.)

So, doing the calculation and rounding off to three sig figs, we get 2.71×10^{23} mol^{-1} atoms. Notice "atoms" never gets written until the end. It is assumed to be there in the case of elements. If you wrote Avogadro's Number with the unit atoms/mole in the problem, you would be correct.

The same type of discussion applies to substances which are molecular in nature, such as water. So the numerator I use here is "molecule" and the problem answer is 1.20×10^{23} molecules.

Once again, the numerator part of Avogadro's Number depends on what is in the problem. Other possible numerators include "formula units," ions, or electrons. These, of course, are all specific to a given problem. When a general word is used, the most common one is "entities," as in 6.022×10^{23} entities/mol.

Let us now continue with more solutions to the example problems above. Here are the same two problems as before, but with gram replacing mole:

1. 0.450 gram of Fe contains how many atoms?
2. 0.200 gram of H_2O contains how many molecules?

Look at the solution steps and you'll see we have to go from grams (on the left) across to the right through moles and then to how many. So, for the first one it would be like this:

Step One: 0.450 g divided by 55.85 g/mol = 0.00806 mol

Step Two: 0.00806 mol x 6.022×10^{23} atoms/mol

and for the second, we have:

Step One: 0.200 g divided by 18.0 g/mol = 0.0111 mol

Step Two: 0.0111 mol x 6.022×10^{23} molecules/mol

Practice Problems

Now, let's see how well you can do the opposite direction. The first two are the one-step type and the second two are the two-step type.

1. Calculate the number of molecules in1.058 mole of H_2O
2. Calculate the number of atoms in 0.750 mole of Fe

1. Calculate the number of molecules in1.058 gram of H_2O
2. Calculate the number of atoms in 0.750 gram of Fe

Go to Answers