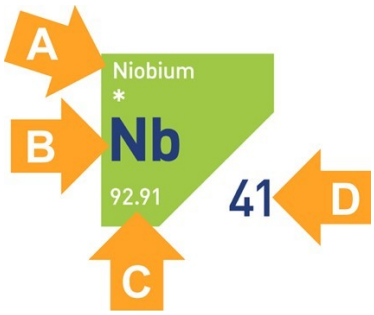
STOICHIOMETRY

Introduction: Just like in preparing your favorite foods, recipes exist for chemicals as well. We can use balanced chemical equations just like a recipe in your favorite cookbook. In chemistry, this process is called stoichiometry.

Which of the numbers represents the atomic mass of the atom below?



- A
- B
- C
- D

If the balanced chemical reaction for the formation of Li_2O is 4 $Li_{(s)}$ + $O_{2(g)}$ → 2 $Li_2O_{(s)}$, how many molecules of $Li_2O_{(s)}$ would you produce if you used up 6 atoms of $Li_{(s)}$?

- 3
- 12
- 2
- 6

AVOGADRO'S NUMBER AND THE MOLE

Before we can dive into stoichiometry, you must first understand **Avogadro's number: 6.022 x 10^{23}**. This is the number of atoms in 12 grams of the isotope carbon-12. As you will see, this number will allow you to make connections between chemical compounds and chemical masses.
To help understand this number, first consider a named number you have likely heard of: a dozen. If you have a dozen eggs, you have 12 eggs, if you have a dozen atoms, you have 12 atoms, etc. We know that a dozen means 12.

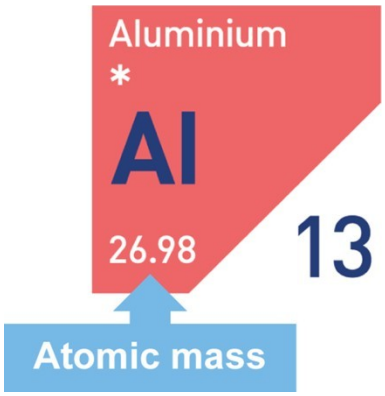
Just as 12 of a substance is a dozen, 6.022 x 10^{23} of a substance is a mole. For example:

- One mole of aluminum atoms is 6.022 x 10^{23} atoms of aluminum.
- If you have 1 mole of cookies, you have 6.022 x 10^{23} cookies
- 1 mole of H_2O is equal to 6.022 x 10^{23} molecules of H_2O

It is important to note that a mole of a substance does not have the same mass of a mole of another substance, just as a dozen eggs would have a much smaller mass than a dozen cars.
For example, the mole of cookies would have a greater mass than the mole of H_2O molecules as these molecules are much less massive than cookies.

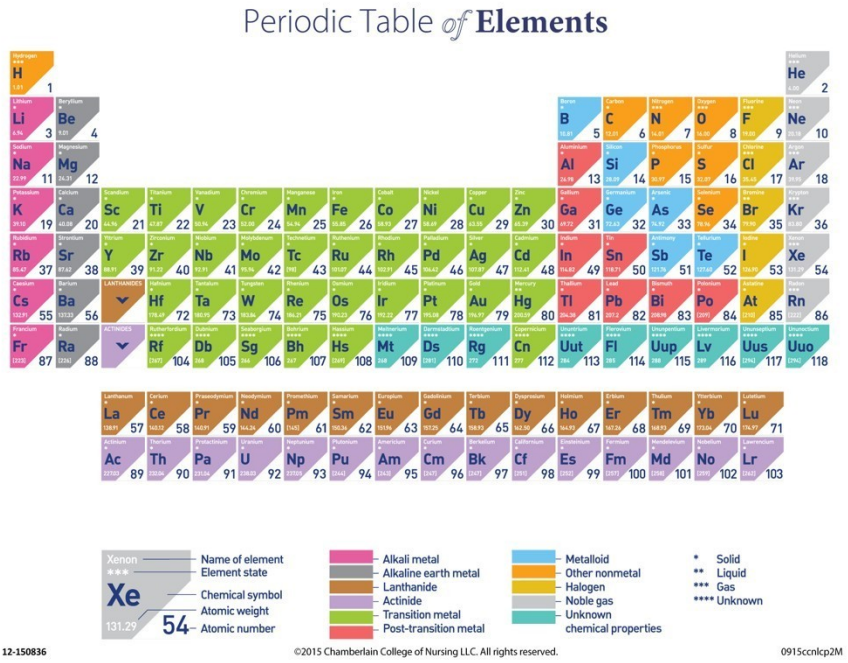
ATOMIC MASS AND MOLAR MASS

We will now learn the relationship between moles and the atomic masses found on the periodic table. As you may recall from our earlier lessons, the periodic table gives us the atomic masses of each substance in the lower left.



The units you use here for atomic mass will be: g/mol (grams per mole). As you can see, the atomic mass of an atom of aluminum can be expressed as 26.98 g/mol. If you were to somehow count out exactly 1 mole (Avogadro's number, 6.022×10^{23}) atoms of Al and put them on a scale, the mass of this sample would 26.98 grams. In other words, an atomic mass is the number of grams of that atom per mole of that atom.

You could also add up the atomic masses of all of the atoms in a molecule to determine the **molecular** mass of that molecule. Using the periodic table, add up the molecular mass of H_2O.



As you see from the formula H_2O, we have two atoms of H and one atom of O in each molecule. We can add these up to get the molecular mass of H_2O:

H: 2 x 1.01 g/mol + O: 1 x 16.00 g/mol = 18.02 g/mol

This means that there are 18.02 grams of H_2O in one mole of H_2O. As an important note: the units of molecular mass are g/mol, NOT just grams and NOT just moles. Just like speed is measured in miles per hour and not miles or hours separately.

Complete the calculations below to determine the molecular masses of the following substances. First fill in the correct values for the number of atoms, then calculate the molecular mass of each molecule

$MgCl_2$	
Number of Mg atoms	1
Number of Cl atoms	2
Molecular Mass of $MgCl_2$	95.21 g/mol