# AVOGADRO’S NUMBER – What’s up with that?

One important property of a mole is that it means a definite number of particles just like a dozen means a number of particles. While a dozen is only 12 particles a **mole is a much larger number—6.02 x 1023 particles.** Elements generally exist as the particles we call atoms. **A mole of carbon contains 6.02 x 1023 atoms of carbon.** A mole of helium contains 6.02 x 1023 atoms of helium. A mole of sodium contains 6.02 x 1023 atoms of sodium. A mole of gold contains 6.02 x 1023 atoms of gold. However, **we have learned about seven elements that exist as diatomic molecules—H2, N2, O2, F2, Cl2, Br2, and I2. For these elements one mole is 6.02 x 1023 molecules. That is, 6.02 x 1023 molecules of hydrogen is one mole of hydrogen,** 6.02 x 1023 molecules of nitrogen is one mole of nitrogen, 6.02 x 1023 molecules of oxygen is one mole of oxygen, etc.

While atoms are the smallest part of an element that still retains the properties of that element, molecules are the smallest parts of covalent compounds that still retain the properties of that compound. (For ionic compounds the smallest part is a combination of + and – ions but for now let’s just consider them to be “molecules”.) Therefore, one mole of a compound contains 6.02 x 1023 molecules of that compound. **One mole of water contains 6.02 x 1023 molecules of water**, one mole of carbon dioxide contains 6.02 x 1023 molecules of carbon dioxide, one mole of ammonia contains 6.02 x 1023 molecules of ammonia, one mole of sodium chloride contains 6.02 x 1023 “molecules” of sodium chloride, etc. (The number 6.02 x 1023 is a measurement, not a definition, and is only good for three significant figures.)

**In all of the above examples one mole of any substance contained the same number of particles**. **But remember, they all had different masses.** The mass of one mole of each material was equal to the gram formula or molecular mass. (This is the same idea as the mass of a dozen. A dozen eggs, a dozen bricks, a dozen dump trucks all contain twelve items but the mass of a dozen eggs is certainly much different than the mass of a dozen bricks which is much different from the mass of a dozen dump trucks!)

The number **6.02 x 1023 is known as Avogadro’s number** in honor of an Italian Professor of physics, Amadeo Avogadro, who did considerable work on the development of atomic theory and the mole concept in about 1810. Given this number we can calculate the number of particles in a known number of moles or the number of moles in a given number of particles.

EXAMPLE: How many molecules of water are there in 3.00 moles of water?

# molecules H20 = 3.00 moles H20 x 6.02 x 1023 molecules of H20 = **1.81 x 1024 molecules H20**

1 mole H20

EXAMPLE: How many moles of neon are there in 2.408 x 1024 atoms of neon?

# moles Ne = 2.408 x 1024 atoms Ne x 1 mole Ne = **4.00 moles Ne**

6.02 x 1023 atoms of Ne

USE AVOGADRO’S NUMBER TO SET-UP AND SOLVE THE FOLLOWING PROBLEMS. Show your work!

**How many molecules are there in:**

1. 2.00 moles of ammonia?

1. 0.50 moles chlorine?

1. 0.250 moles oxygen?
2. 4.00 moles of sulfur dioxide?
3. 2.50 moles of methane?

**How many moles are there in:**

1. 1.505 x 1024 molecules of sucrose sugar (C6H12O6)?
2. 1.806 x 1024 molecules of bromine?
3. 3.01 x 1024 atoms of argon?