http://www.mathamazement.com/Lessons/Everyday-Math/05_Miscellaneous/05_03_Important-Numbers/avogadros-number.html

5.3.10. Avogadro's Number (NA ≈ $6.022 * 10^{23}$)

Avogadro's number (NA), also known as a mole, is a very important number in chemistry and physics. Take an element, say copper, and look up its atomic weight. The atomic weight of copper happens to be approximately 63.55. What this means is that 63.55 grams of copper contains precisely 6.022 * 1023 copper atoms. That's a lot of atoms! What about carbon? The atomic weight of carbon is 12.01, meaning that 12.01 grams of carbon has 6.022 * 1023 carbon atoms.

Why is a smaller mass of carbon than of copper required to produce the same number of atoms? This is because carbon atoms are lighter than copper atoms. Indeed, the atomic weight of an element is a measurement of the average mass of each of its atoms, in appropriate units. (It is a measure of average mass because not all atoms of the same element have the same mass. Specifically, the different isotopes of the same element all have slightly different masses.) The mass of an atom is measured in atomic mass units. An atomic mass unit is an incredibly small unit of mass. It is just slightly more than the mass of a proton or neutron, which turns out to be approximately 1.66 * 10-24 grams. This number is the recipricol of Avogadro's number, meaning that a mole of protons or neutrons has a mass of nearly 1 gram. For this reason, the atomic weight of an element is approximately equal to the sum of the number of protons and neutrons in each of its atoms.

Why is Avogadro's number so important? It is important in chemistry in order to know the correct proportion of chemicals to use to produce a certain reaction. For instance, suppose you want to make a kilogram of table salt out of its constituent elements, sodium and chlorine. How much sodium and how much chlorine should you use? The atomic weight of sodium is 22.99 and that of chlorine is 35.45. Now the chemical formula of salt is NaCl, meaning that each molecule of salt contains one sodium (Na) atom and one chlorine (Cl) atom. Thus, the molecular weight of salt is 22.99 + 35.45 = 58.44. This means that one mole of salt has a mass of 58.44 grams and contains 22.99 grams of sodium and 35.45 grams of chlorine. Now one kilogram of salt contains 1000 / 58.44 = 17.11 moles of molecules, meaning it has 17.11 moles of sodium and 17.11 moles of chlorine. The mass of 17.11 moles of sodium is 17.11 * 22.99 = 393.4 grams and the mass of 17.11 moles of chlorine is 17.11 * 35.45 = 606.6 grams. Thus, it is necessary to mix 393.4 grams of sodium and 606.6 grams of chlorine in order to make a kilogram of salt.

Because atoms are so small, Avogadro's number is incredibly large. To get a feeling for how big it is, consider the following facts:

- A stack of Avogadro's number of sheets of paper would stretch beyond Polaris (the North Star), 680 light-years away.
- Avogadro's number of grains of sand spread across California would be as high as a ten-story building.
- Avogadro's number of marshmallows spread across the United States would be 1000 kilometers (600 miles) high.
- If Avogadro's number of pennies were divided evenly throughout the world, every person would have 10 trillion dollars. However, life on earth would probably not be possible, being buried under 1.3 km (0.8 miles) of pennies.