2.3: Avogadro's Hypothesis

Avogadro's hypothesis is another classical gas law. It can be stated: At the same temperature and pressure, equal volumes of different gases contain the same number of molecules.

When the mass, in grams, of an ideal gas sample is equal to the ***gram molar mass*** (traditionally called the ***molecular weight***) of the gas, the number of molecules in the sample is equal to ***Avogadro's number***, $\overline{N}^1$. Avogadro's number is the number of molecules in a ***mole***. In the modern definition, one mole is the number of atoms of C^{12} in exactly 12 g of C^{12}. That is, the number of atoms of C^{12} in exactly 12 g of C^{12} is Avogadro's number. The currently accepted value is $6.02214199 \times 10^{23}$molecules per mole. We can find the gram atomic mass of any other element by finding the mass of that element that combines with exactly 12 g of C^{12} in a compound whose molecular formula is known.

The validity of Avogadro's hypothesis follows immediately either from the fact that the Boyle's law constant, $\alpha(T)$, is the same for any gas or from the fact that the Charles' law constants, $\beta(P)$ and $\gamma(P)$, are the same for any gas. However, this entails a significant circularity; these experiments can show that $\alpha(T)$, $\beta(P)$, and $\gamma(P)$ are the same for any gas only if we know how to find the number of moles of each gas that we use. To do so, we must know the molar mass of each gas. Avogadro's hypothesis is crucially important in the history of chemistry: Avogadro's hypothesis made it possible to determine relative molar masses. This made it possible to determine molecular formulas for gaseous substances and to create the atomic mass scale.