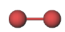
2.7: The Amount of Substance- Moles

According to the atomic theory, atoms are the units of chemical reactions. The formula $HgBr_2$ indicates that each molecule of this substance contains one mercury and two bromine atoms. Therefore, if we ask how much bromine is required to make a given quantity of mercury (II) bromide, the answer is two bromine atoms for each mercury atom or two bromine atoms per molecule. In other words, how much substance we have depends in a very important way on how many atoms or molecules are present.

So far, we've dealt with mass ratios. Is there a way to change masses of atoms into numbers of atoms, so it is easy to see *how much* of one element will react with another, just by looking at the number of atoms that are needed?

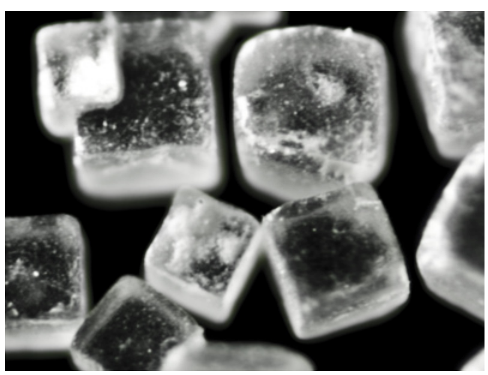
As we see below, there seems to be no fundamental connection between the number of atoms or molecules in the chemical equations, and typical measures of "how much":

the number of atoms or molecules in the chemical equations

$1\ \mathrm{Hg}\ (l)$	$+$	$1\mathrm{Br_2}(l)$	$\rightarrow$	$1\ \mathrm{HgBr_2}(s)$
1 atom 		1 molecule 		1 molecule
1.00 g		0.797 g		1.797 g
1.00 ml		3.47 ml		0.30 ml

"How much?" in the above sense of the quantity of atoms or molecules present is not the same thing as "how much" in terms of volume or mass. It takes 3.47 cm^3 $Br_2(l)$ to react with a 1 cm^3 sample of $Hg(l)$. That same 1 cm^3 $Hg(l)$ would weigh 13.59 g, but only 10.83 g $Br_2(l)$ would be needed to react with it. In terms of volume, more bromine than mercury is needed, while in terms of mass, less bromine than mercury is required. In the atomic sense, however, there are exactly *twice* as many bromine atoms as mercury atoms and twice as much bromine as mercury.

Luckily, the International System of Measurements (IUPAC) has a measure of ***amount*** that reflects the number of atoms present, and it is called the ***mole.*** For perspective, 1 mole of salt cubes (like those seen below) would form a cube 27 miles square. For additional perspective, it would take the fastest marathoner in the world just about 2 hours to run the length of one side. A mole is a huge number... Find out more about it on the next page!



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