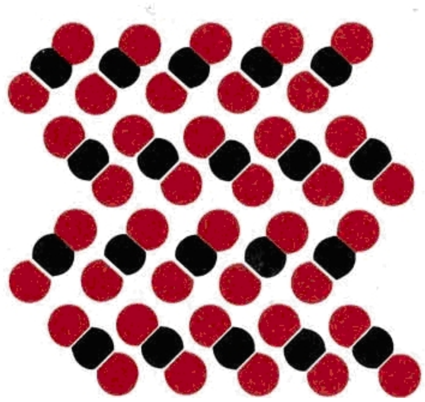
2.1: Prelude to Atoms and Reactions

Two very important things that chemists (and scientists in general) do include making quantitative measurements, and communicating the results of experiments as clearly and unambiguously as possible. We will now deal with another important activity of chemists—the use of their imaginations to devise theories or models to interpret their observations and measurements. Such theories or models are useful in suggesting new observations or experiments that yield additional data. They also serve to summarize existing information and aid in its recall.



The **atomic theory**, first proposed in modern form by John Dalton, is one of the most important and useful ideas in chemistry. It interprets observations of the every-day world in terms of particles called atoms and molecules. **Macroscopic** events—those which humans can observe or experience with their unaided senses—are interpreted by means of **microscopic** objects—those so small that a special instrument or apparatus must be used to detect them. (Perhaps the term *submicroscopic* really ought to be used, because most atoms and molecules are much too small to be seen even under a microscope.) In any event, chemists continually try to explain the macroscopic world in microscopic terms. The contrasting properties of solids, liquids, and gases, for example, may be ascribed to differences in spacing between and speed of motion of the constituent atoms or molecules. In the form originally proposed by John Dalton(opens in new window), the atomic theory distinguished elements from compounds and was used to explain the law of constant composition and predicted the law of multiple proportions. The theory also agreed with Lavoisier's law of conservation of mass. An important aspect of the atomic theory is the assignment of relative masses (atomic weights) to the elements. Atoms and molecules are extremely small. Therefore, when calculating how much of one substance is required to react with another, chemists use a unit called the mole. One mole contains 6.022×10^{23} of whatever kind of microscopic particles one wishes to consider. Referring to 2 mol Br_2 specifies a certain number of Br_2 molecules in the same way that referring to 10 gross of pencils specifies a certain number of pencils. The quantity which is measured in the units called moles is known as the amount of substance. The somewhat unusual number 6.022×10^{23}, also referred to as the Avogadro Constant, which specifies how many particles are in a mole, has been chosen so that the mass of 1 mol of atoms of any element is the atomic weight of that element expressed in grams. Similarly, the mass of a mole of molecules is the molecular weight expressed in grams. The molecular weight is obtained by summing atomic weights of all atoms in the molecule. This choice for the mole makes it very convenient to obtain molar masses–simply add the units grams per mole to the atomic or molecular weight. Using molar mass and the Avogadro constant, it is possible to determine the masses of individual atoms or molecules and to find how many atoms or molecules are present in a macroscopic sample of matter. A table of atomic weights and the molar masses which can be obtained from it can also be used to obtain the empirical formula of a substance if we know the percentage by weight of each element present. The opposite calculation, determination of weight percent from a chemical formula, is also possible. Once formulas for reactants and products are known, a balanced chemical equation can be written to describe any chemical change. Balancing an equation by adjusting the coefficients applied to each formula depends on the postulate of the atomic theory which states that atoms are neither created, destroyed, nor changed into atoms of another kind during a chemical reaction.