Section 4: Determination of Atomic Weights for Gaseous Elements (In Progress)

Now that we can count atoms and molecules to determine molecular formulae, we need to determine relative atomic weights for all atoms. We can then use these to determine molecular formulae for any compound from the mass ratios of the elements in the compound.

We begin by examining data on reactions involving the Law of Combining Volumes. Going back to the nitrogen oxide data given here, we recall that there are three compounds formed from nitrogen and oxygen. Now we measure the volumes which combine in forming each. We find that 2 liters of oxide B can be decomposed into 1 liter of nitrogen and 1 liter of oxygen. From the reasoning above, then a nitrogen particle must contain an even number of nitrogen atoms. We assume for now that nitrogen is N2

. We have already concluded that oxygen is O2. Therefore, the molecular formula for oxide B is NO, and we call it nitric oxide. Since we have already determined that the oxygen to nitrogen mass ratio is 1.14 : 1, then, if we assign oxygen a mass of 16, as above, nitrogen has a mass of 14. (That is 161.14=14.) 2 liters of oxide A is formed from 2 liters of oxygen and 1 liter of nitrogen. Therefore, oxide A is NO2, which we call nitrogen dioxide. Note that we predict an oxygen to nitrogen mass ratio of 3214=2.28:1, in agreement with the data. Oxide C is N2O, called nitrous oxide, and predicted to have a mass ratio of 1628=0.57:1

, again in agreement with the data. We have now resolved the ambiguity in the molecular formulae.

What if nitrogen were actually N4

? Then the first oxide would be N2O, the second would be N2O2, and the third would be N4O. Furthermore, the mass of a nitrogen atom would be 7. Why don't we assume this? Simply because in doing so, we will always find that the minimum relative mass of nitrogen in any molecule is 14. Although this might be two nitrogen atoms, there is no reason to believe that it is. Therefore, a single nitrogen atom weighs 14, and nitrogen gas particles are N2.