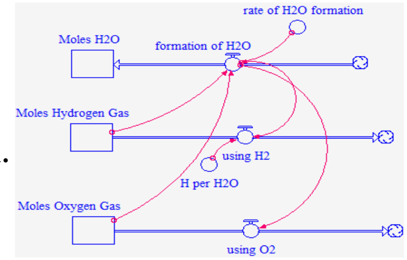
Stoichiometry: Bridging Atomic and Observational Scales



When the size of an atom (10^{-10} meters) is compared to the limit of what can be seen by the human eye (~10^{-4} meters) one quickly realizes the large difference in scale between atomic interactions and the physical and chemical observations resulting from a chemical reaction. Chemistry, as a discipline, has evolved to encompass both of these scales and has given us a way to understand microscopic events in terms of changes in things that we can feel, see or notice in some physical way. Measurement of mass (grams) is typically what we use to characterize these changes; therefore we must use a method to relate amounts of atoms with various chemical properties to a physical amount that we can manipulate. The amount of any substance expressed in terms of **moles** comprises this method.

1 mole = 6.022×10^{23} anythings (people, pennies or posies)

1 mole Copper (Cu) =6.022×10^{23} Cu atoms = 63.55 grams

1 mole of Oxygen (O) = 6.022×10^{23} O atoms = 16.00 grams

1 mole of Cupric Oxide (CuO) contains 1 mole of Cu and 1 mole of O
which together = 6.022×10^{23} CuO molecules = 79.55 grams

If you read carefully, you noticed that a mole is a mole regardless of whether it comes in the form of copper, oxygen or pennies it always is 6.022×10^{23}; however, it's important to understand that atomic mass varies from one element to the next, and therefore each element has a particular molar mass attributed to the mass of one mole of its atoms (please see the periodic table in your text or http://www.webelements.com).

Balancing Chemical Reactions » *Law of Conservation of Mass: Mass can neither be created nor destroyed but may change form*

Chemical reactions which arise from collisions of two or more atoms or molecules in space typically yield energetically favored products; and although the prediction of these products may sometimes seem difficult, we know that the amount of a particular material will not change from beginning to end because of the Law of Conservation of Mass. A reaction, therefore, is written in the form of an equation and relates changes that occur as a result of interactions at the atomic level:

$$\mathbf{2H_2 + O_2 >> 2H_2O}$$

In the above expression, two hydrogen gas molecules react with one molecule of oxygen gas to form two molecules of water. Take care to notice that this ratio ($2H_2$ to 1 O_2) is constant when trying to create water, and in accordance with mass conservation, equal number of O and H atoms exist on each side of the equation. This ratio would also hold true if we wanted to change the scale of this reaction to something that we could observe in the classroom, provided we express the reaction in terms of moles instead of molecules. Remembering that one mole of anything is 6.022×10^{23} , we may conclude

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that the reaction involves two moles of H_2 gas molecules combining with one mole of O_2 gas molecules to form two moles of water.

At times, however, you may be presented with a chemical reaction that involves unequal amounts of a particular atom and in order to examine this reaction accurately you will first need to "balance" the reaction by making sure that equal amounts of a particular element exist on each side of the arrow.

Your goal today is to create a balanced chemical reaction by arranging the symbols that you'll receive from the instructor in the proper ratio to form the compound shown on the product card. If you do not have all of the necessary "elements" to form your product compound you must exchange "elements" with your classmates until you have the proper ratio!

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Now translate your symbols into variables and write down a balanced chemical reaction of the form A+B >…

Modeling Chemical Reactions

Use the balanced chemical reaction for the formation of water and the STELLA program provided on your computer to complete the table below

Component	**Case #1**	**Case#2**	**Case#3**
H_2	100	50	25
O_2	50	100	100
Moles H_2O formed			

Analysis

For cases #1-3 above, what is the ratio of each reactant to the amount of water formed? How do these ratios compare with ratios in the balanced chemical equation above?

Which reactant limits the production of H2O? (Several responses may be needed!) How does it limit production?

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