Name: *Answer Key*

Period: ______

Balancing Equations with LEGOs

Introduction

A balanced chemical equation tells the relative proportions of each of the molecules in a particular reaction.

Dalton's Law tells us that "atoms are conserved in chemical reactions." This means that any atoms that appear on one side of a chemical equation (reaction) have to also appear on the other side. For example, consider the following chemical equation:

$$SiO_2 + 4\,HF \longrightarrow SiF_4 + 2\,H_2O$$

This equation tells us that one molecule of SiO_2 (silicon dioxide) reacts with four molecules of HF (hydrofluoric acid) to form one molecule of SiF_4 (silicon tetrafluoride) plus two molecules of H_2O (water).

In other words, if we were to take apart the one SiO_2 molecule and the four HF molecules, we would have one Si, 2 O, 4 H and 4 F atoms. This would give us exactly enough atoms to build one SiF_4 molecule plus two H_2O molecules.

In this lab activity, you will use LEGO blocks to represent individual atoms. First, you will build the "molecules" of reactants. Once you have done this, you will take apart the reactants into individual "atoms" and make the products out of those atoms.

Using LEGOs to Balance Equations

For each of the chemical equations in this section, use the following procedure.

1. Decide which color LEGO will be which element. Each "element" should be a different color.
2. Label each of the LEGOs with its element symbol, using a water-soluble pen.
3. Build several (at least five) of each of the reactant "molecules".
4. Take one "molecule" of each reactant apart into its individual atoms. Try to build a complete set of products.
5. If you have any "atoms" left over, try to build more products out of them. If you need more of one kind of atom, take apart some of the reactant "molecules" that contain that atom. Keep a count of the number of "molecules" of each reactant you use.
6. You are finished when you have a set of products, and no atoms from the reactants left over.
7. Write down the final numbers of "molecules" of each reactant you used, and the final numbers of "molecules" of each product that you made. This will be the balanced chemical equation.
8. Wash the water-soluble marker off the LEGOs with a wet paper towel.

1. $\mathit{2}\,H_2O_2 \longrightarrow \ \mathit{2}\,H_2O + \ \mathit{1}\,O_2$

H_2O_2 Used	H_2O Made	O_2 Made

2. $\mathit{1}\,C_3H_8 + \ \mathit{5}\,O_2 \longrightarrow \ \mathit{3}\,CO_2 + \ \mathit{4}\,H_2O$

C_3H_8 Used	O_2 Used	CO_2 Made	H_2O Made

3. $\mathit{2}\,KClO_3 \longrightarrow \ \mathit{2}\,KCl + \ \mathit{3}\,O_2$

$KClO_3$ Used	KCl Made	O_2 Made

Using LEGOs to Check Balanced Equations

For each of the chemical equations in this section, use the following procedure.

1. Balance the chemical equation.
2. Decide which color LEGO will be which element. Each "element" should be a different color.
3. Label each of the LEGOs with its element symbol, using a water-soluble pen.
4. Build the number of "molecules" of each of the reactants that you determined from your balanced equation.
5. Take the reactants apart. Build the products.
6. Write down the final numbers of "molecules" of each reactant you actually used, and the final numbers of "molecules" of each product that you actually made. These numbers should agree with your balanced chemical equation.
7. Wash the water-soluble marker off the LEGOs with a wet paper towel.

1. $\mathit{4}\,KClO_3 \longrightarrow \mathit{3}\,KClO_4 + \mathit{1}\,KCl$

$KClO_3$ Used	$KClO_4$ Made	KCl Made

2. $\mathit{1}\,P_2O_5 + \mathit{3}\,H_2O \longrightarrow \mathit{2}\,H_3PO_4$

P_2O_5 Used	H_2O Used	H_3PO_4 Made

3. $\mathit{4}\,Sb + \mathit{3}\,O_2 \longrightarrow \mathit{1}\,Sb_4O_6$

Sb Used	O_2 Used	Sb_4O_6 Made

Excess of One Reactant

The balanced equation tells how many molecules (or moles) of each chemical participate in the reaction. What would happen if you had too much of one reactant or too little of another?

Consider the unbalanced equation:

$$\mathit{4}\,NH_3 + \quad \mathit{3}\,O_2 \longrightarrow \quad \mathit{2}\,N_2 + \quad \mathit{6}\,H_2O$$

Using the above methods, we could figure out how much of each would react in a balanced equation. However, suppose we put exactly 4 moles of NH_3 and 6 moles of O_2 in a container and let them react. What would be in the container when we finished?

To find out, using legos, do the following:

1. Build 4 NH_3 "molecules".
2. Build 6 O_2 "molecules".
3. Build as many N_2 and H_2O "molecules" as you can by taking apart NH_3 "molecules" and O_2 molecules, as you did in section 1 above.
4. When you run out of something, you're done. Note how many of each molecule you used, and how many (if any) of each you had left over.

$$\mathit{4}\,NH_3 + \quad \mathit{3}\,O_2 \longrightarrow \quad \mathit{2}\,N_2 + \quad \mathit{6}\,H_2O$$

NH_3 Used	NH_3 Left	O_2 Used	O_2 Left	N_2 Made	H_2O Made

Questions

1. Which molecule did you have excess of?

   O_2

2. What happened to the excess?

   It didn't react, so it was left over in the container after the reaction finished.

3. When you have an excess of one reactant, does the law of conservation of mass still apply? If not, why not?

   Yes. All of the oxygen atoms either react and become part of the product H_2O *molecules, or don't react and remain as* O_2.