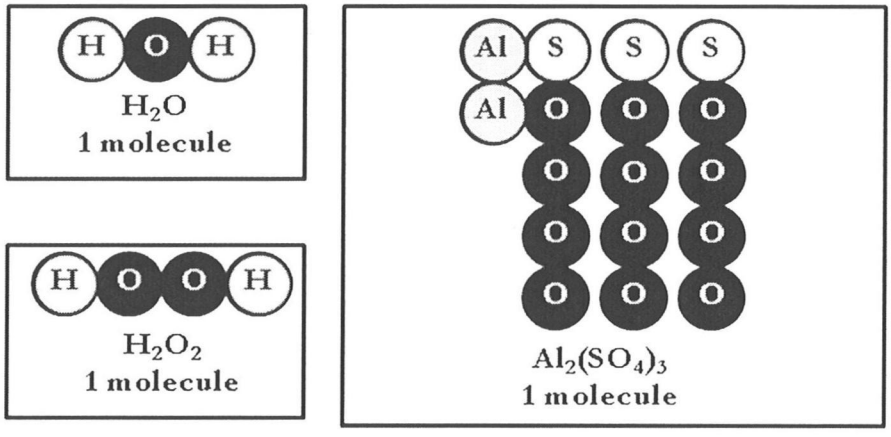
Name: _____ Date: _____ Period: _____

Balancing Act

Why?

In a chemical reaction, matter cannot be created or destroyed. The mass of the reactants in a chemical reaction must be equal to the mass of the products. It is not possible to start a chemical reaction with 2 atoms of hydrogen and produce 2 atoms of gold. Similarly, it is not possible to start a chemical reaction with 2 atoms of hydrogen and produce only 1 atom of hydrogen. When a chemical equation is written, the same number of each type of atom must appear on both the product and reactant side.

Model 1



1) **According to Model 1:**

a) How many atoms of hydrogen and oxygen are in 1 molecule of water, H_2O?

H: _____ O: _____

b) How many atoms of hydrogen and oxygen are in 1 molecule of H_2O_2, hydrogen peroxide?

H: _____ O: _____

c) How many atoms of aluminum, sulfur, and oxygen are in 1 molecule of aluminum sulfate, $Al_2(SO_4)_3$?

Al: _____ S: _____ O: _____

d) How many atoms of hydrogen and oxygen are in 2 molecules of water?

H: _____ O: _____

e) How many atoms of hydrogen and oxygen are in 8 molecules of hydrogen peroxide?

H: _____ O: _____

f) How many atoms of aluminum, sulfur, and oxygen are in 3 molecules of aluminum sulfate?

Al: _____ S: _____ O: _____

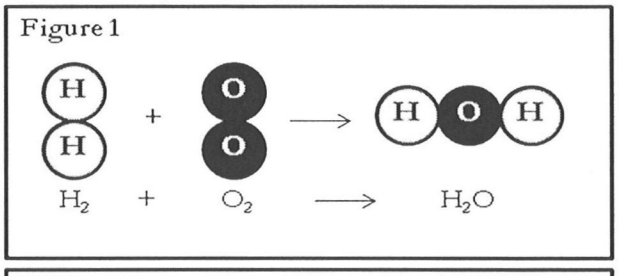
2) Write how would you indicate 2 water molecules using chemical symbols: _____.

3) Using complete sentences, explain the difference between these two chemical formulas: 4 H_2O and H_8O_4.

Read This!

In a chemical equation, two types of numbers can be used to represent the number of atoms involved in the reaction. The first type of number is called a **subscript**. Subscripts are written after the element symbol in a chemical formula to indicate the number of atoms present in the compound. The second type of number is called a **coefficient**. A coefficient is a number placed in front of a chemical formula to indicate the number of atoms or molecules involved in a chemical reaction. Chemical equations should always be balanced; that is a chemical equation should have the same number of atoms on both the reactant and product side of the equation. When balancing a chemical equation, **subscripts** are never changed. A **coefficient** can be used to ensure an equal number of atoms are found in both the reactant and product side of a chemical equation.

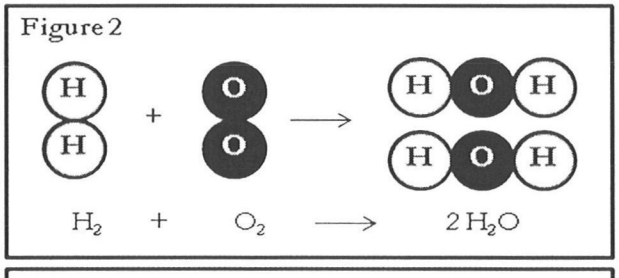
Model 2



1) In Figure 1, how many molecules of reactants are shown? How many molecules of products are shown?

Reactants: _____ Products: _____

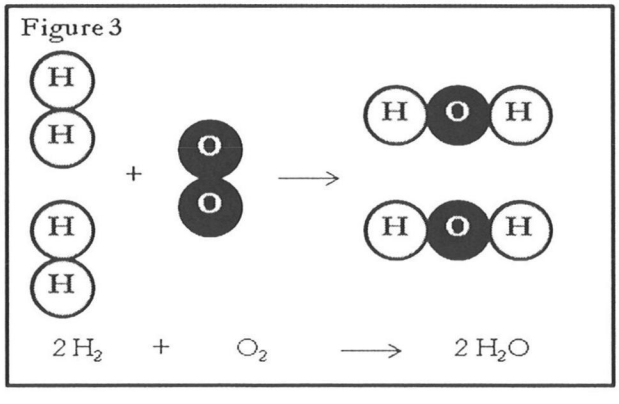
2) Explain why the reaction represented in Figure 1 **is not** balanced.



3) In Figure 2, how many molecules of reactants are shown? How many molecules of products are shown?

Reactants: _____ Products: _____

4) Explain why the reaction represented in Figure 2 **is not** balanced.



5) In Figure 3, how many reactant molecules are shown? How many product molecules are shown?

Reactants: _____ Products: _____

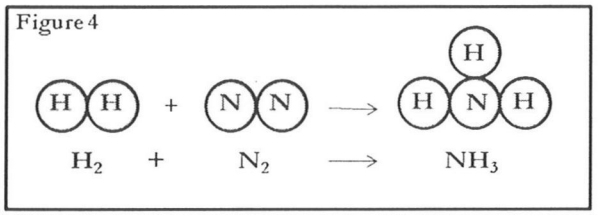
6) Using complete sentences, explain why the reaction represented in Figure 3 **is** balanced.

7) Write the balanced chemical equation to show how hydrogen and oxygen combine to produce water.

Read This!

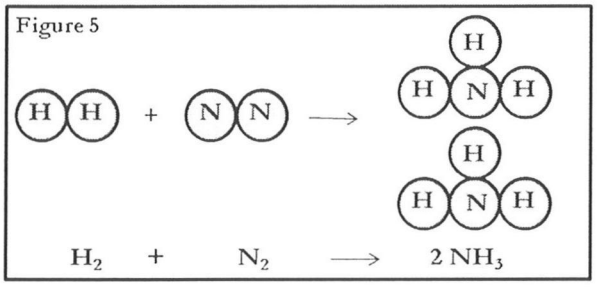
Model 3 below illustrates the Haber process, a method used to produce **ammonia** that was developed during World War I. When the Allies blocked off all trade routes going to and from Germany, the Germans lost access to their source of sodium nitrate and potassium nitrate which were needed to make explosives. In response to the need for a source of nitrates, chemist Fritz Haber developed what is now known as the Haber Process, which combines molecular nitrogen from the air with molecular hydrogen to form ammonia gas. (Note: air is 78% nitrogen, so this synthesis is very clever because air is free and abundant.) Using the Haber Process, the Germans had an uninterrupted source of nitrogen in a form that could be used to make the nitrates needed for explosives. (http://haberchemistry.tripod.com/)

Model 3

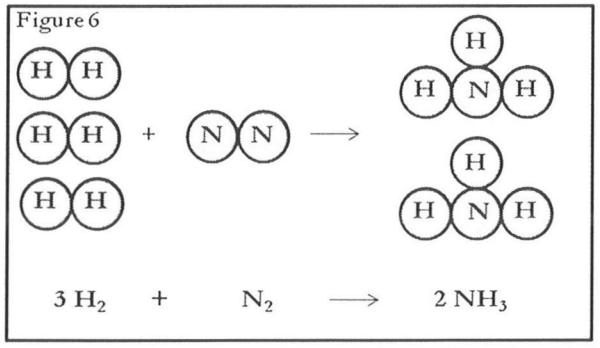


1) Describe what is being shown in Figure 4.

2) Does Figure 4 represent a balanced chemical equation? Why or why not? Explain your reasoning in terms of the type and number of each atom present.



3) Describe what is being shown in Figure 5.



4) Does Figure 5 represent a balanced chemical equation? Why or why not? Explain your reasoning in terms of the type and number of each atom present.

5) Describe what is being shown in Figure 6.

6) Does Figure 6 represent a balanced chemical equation? Why or why not? Explain your reasoning in terms of the type and number of each atom present.

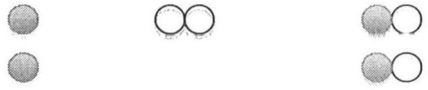
7) Write a balanced chemical equation for the synthesis of ammonia from hydrogen and nitrogen gas.

Extension Questions

1) Using the smallest whole number coefficients, balance the following reactions. Draw diagrams like those in the example for Equations a, b, and c.

Example:

__2__ K + __1__ Cl_2 → __2__ KCl



a) _____ HgO → ___ Hg + ___ O_2

b) _____ Fe + _____ O_2 → _____ Fe_2O_3

c) _____$KClO_3$ → ____ KCl + ____ O_2

d) _____ Cu + _____ $AgNO_3$ → _____ $Cu(NO_3)_2$ + _____ Ag

e) _____ $Ca(OH)_2$ + _____ H_2SO_4 → _____ HOH + _____ $CaSO_4$

f) _____ C_2H_6 + _____O_2 → _____ CO_2 + _____ H_2O

Problems

Write the formulas for the components in each reaction and, using the smallest whole number coefficients, balance each equation.

Example: Solid magnesium reacts with oxygen gas to produce solid magnesium oxide.

2 Mg(s) + O_2(g) --> 2 MgO(s)

1. Solid carbon reacts with oxygen gas to produce carbon dioxide gas.

2. Zinc metal reacts with hydrogen chloride to produce hydrogen gas and aqueous zinc chloride.

3. Solid sodium chloride is broken down into its elements.