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PREPARATION FOR HIGH SCHOOL CHEMISTRY
Grades 4-8 by Francis T. Sganga

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Maurice Fisher, Publisher

THE CHEMISTRY OF PHOTOSYNTHESIS

When sunlight strikes the green leaves of a plant like sugar cane, it triggers a **chemical reaction** that eventually supplies us with all of the food we eat. Hamburgers come from animals that graze on plants. Without plants, there would be no hamburger, or us.



CHEMICAL EQUATIONS SHOW CHEMICAL REACTIONS

In a **chemical reaction** ingredients [*reactants*] are combined when they react with each other *producing a different substance* called a **product**..

A **chemical equation** is somewhat like a mathematical equation:

MATHEMATICAL EQUATION

Ingredients		Product
2	x =	6

CHEMICAL EQUATION

[A Chemical Reaction]

Ingredients		Product	
2H ₂	+	O ₂	==> 2H ₂ O <= Water
Gases		Liquid	

A SPECIAL NOTE

SUBSCRIPTS AND COEFFICIENTS

The ₂ in the symbols for the elements H₂ and O₂ is called a **subscript**. It tells us there are **2 atoms** of each element. That's because the 2 elements normally exist as *pairs of atoms*, and are therefore called **molecules**. The equation says "**2 molecules of hydrogen react with 1 molecule of oxygen producing 2 molecules of water.**"

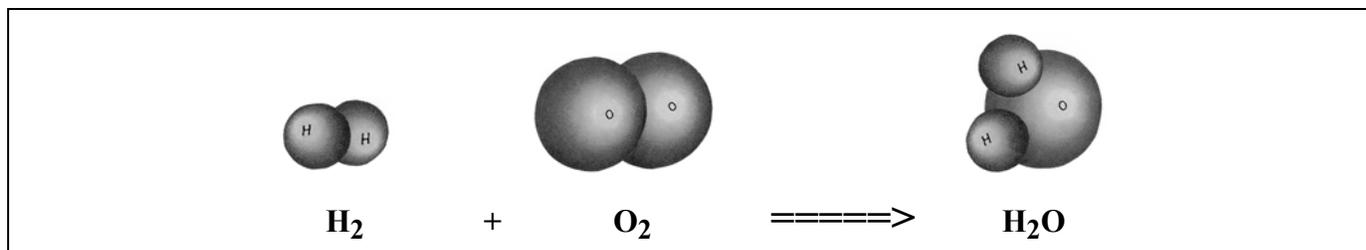
The 2 on the left in 2H₂ is called a **coefficient** as it is in algebra, and as it does in algebra, it *multiplies everything to its right*. This means that 2H₂ = **4** atoms of hydrogen.

Where **no subscript or coefficient** is used, it is **understood to be 1**.

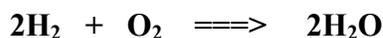
Chemical reactions take place everywhere. Inside plants, inside our bodies, and even in solids like iron, that eventually turns to rust. What is a **chemical reaction**? It is a process that starts with a set of **reactants** [ingredients] and changes them into something else called a **product**. The ingredients for a cake become a *cake* after baking them. The ingredients for sugar, which are carbon dioxide [CO₂] and water [H₂O], plus nutrients from the soil, **react** together to become *sugar* after sunlight "bakes" them in the green leaves of a sugar cane plant producing the "cake" sugar.

A MIRACLE ! TWO GASES COMBINE TO FORM WATER !

The following illustration shows *how* water is formed. But *it doesn't reflect what really happens* when the two elements combine. There is only *1 atom of oxygen* to the right of the arrow. *There should be 2*, because *you cannot have fewer atoms* in the *product* than you have in the *reactants*.



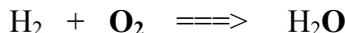
Further study by chemists revealed that the correct chemical equation showing that the burning of *hydrogen* in the presence of *oxygen* gives *water* is:



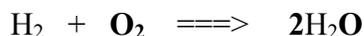
The equation above is "*balanced*," which means that *both sides* of the equation contain the *same number of atoms* [6], *which they must*. This is how *equations* may be *balanced* using paper and pencil:

BALANCING EQUATIONS

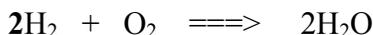
1. *Before balancing*, the equation looks like this, which correctly shows *hydrogen and oxygen molecules*:



2. This equation is *unbalanced* because there are 2 oxygen atoms to the left of the arrow and only 1 to its right. To achieve balance, *coefficients* are used. Placing the *coefficient 2* to the left of the water molecule, as shown below, balances the oxygen atoms: 2 on the left; 2 on the right.



3. *Hydrogen* is now unbalanced: 2 on the left; 4 on the right. Placing the *coefficient 2* to the left of the *hydrogen* molecule, as shown below, **balances hydrogen**:



4. With the *same number of atoms* [6] on both sides of the equation, *it is now balanced*.

IMPORTANT NOTE

1. Only whole number *coefficients* may be juggled in balancing equations.
2. *Subscripts* cannot be changed. To do so would result in the wrong formula for the substance. For example, H_2O is *water*; H_2O_2 is *peroxide*. CO is the deadly gas, carbon monoxide; CO_2 is the gas we exhale, carbon dioxide; O_2 is oxygen, O_3 is ozone.
3. Now cover the text above with a sheet of paper, then try balancing this equation on your own:

