Chemical Reactions: The Law of Conservation of Mass

What happens in a Chemical Reaction?

- Chemical bonds in the reactants are broken, then atoms are rearranged to form new substances (products).
- The amount of matter does not change during a chemical reaction, the atoms are only rearranged to form new substances.
- This is evidenced (shown) in a balanced chemical equation.

What is a Chemical Equation?

- A chemical equation is a way that scientists represent a chemical reaction that has occurred. It shows the rearrangement of atoms in a chemical reaction.
  - It contains the chemical formulas of the substances involved in the reaction.
  - An arrow is used to distinguish between the reactants and products, and can be understood as meaning "yields" or "makes".
  - Reactants are the substances broken apart or combined in a chemical reaction (what you start with!) and they are located on the left side of the arrow in a chemical equation.
  - Products are new substances formed in a chemical reaction (what you end with!) and they are located on the right side of the arrow in a chemical equation.
  - Ex: $C + O_2 \rightarrow CO_2$
    - This equation says "carbon reacts with oxygen to yield (make) carbon dioxide."
    - The arrow shows the direction of the reaction: reactants → products.

What is the Law of Conservation of Mass?

- When substances react with each other, many changes can take place, but in every case the total amount of matter afterward is the same as before.
- Discovered by Lavoisier—French chemist
- Law of Conservation of Mass: in a chemical rxn, mass (atoms) is neither created nor destroyed
  - *Mass of reactants = mass of products*
  - All atoms present in the reactants are also present in the products. There must be the same number of atoms in the products and reactants.

Mass Stays the SAME

- The mass of the products must be the same as the mass of the reactants.
  - You do not magically gain or lose mass!!!
- Example: If you have 2 grams of Na react with 1 gram of Cl to make NaCl, you know you must have 3 grams of NaCl in the products!
  - $Na + Cl \rightarrow NaCl$

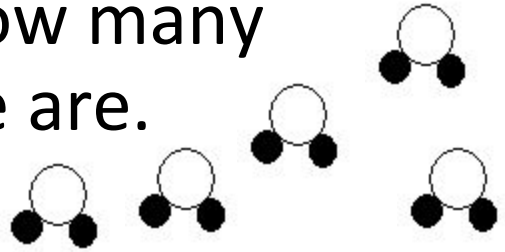
    $2g + 1g \rightarrow 3g$

Number of Atoms Stays the SAME

- You must have the SAME number of atoms of EACH element on both sides of the equation.
- If you have 2 atoms of oxygen in the reactants, you must have 2 atoms of oxygen in the products. (You do not magically gain or lose atoms!!!)
- This is NOT something someone made up; it's how chemical reactions happen in nature!

How can I tell how many atoms of each element there are?

- Coefficient: the "big" number written in front of a chemical formula that tells you how many molecules of that substance there are.
  - Ex: 5 H_2O = 5 molecules of water



- The subscript tells you how many atoms of each element there are.
- The coefficient times the subscript tells you how many total atoms of that element are present.
  - 5 H_2O = 10 atoms of Hydrogen, 5 atoms of Oxygen
- If there is no coefficient, then there is only one molecule of that substance!

What does it mean to Balance a Chemical Equation?

- Sometimes we have to "balance" a chemical equation to make sure that we have the same number of atoms of each element on both sides of the equation. To do this, we change the number of molecules by changing the coefficients (NEVER THE SUBSCRIPTS!!!) until we have the same number of atoms of each element on both sides. When we do this, we are saying how many molecules of each substance must be present before the reaction will take place (remember: this is not something scientists made up; this is how the reactions happen in nature!).

How do I know if an Equation is Balanced?

1. Check the number of atoms of each element on both sides of the equation (reactants and products).
2. If the number of atoms of each element is the SAME on both sides, then the equation is balanced.

Example:

$H_2 + O_2 \rightarrow H_2O$: Not Balanced

$2H_2 + O_2 \rightarrow 2H_2O$: Balanced