DESCRIBING CHEMICAL REACTIONS

Objectives:
- List three observations that suggest that a chemical reaction has taken place
- List three requirements for a correctly written chemical equation
- Write a word equation and a formula equation for a given chemical reaction
- Balance a formula equation by inspection
WHAT IS A CHEMICAL REACTION?

- **Chemical reaction**: the process by which one or more substances are changed into one or more new substances
  - Represented by chemical equations

- **Chemical equation**: a shorthand expression that represents a chemical reaction
  - Shows the relative amount of each substance taking place in a chemical reaction
SIGNS OF A CHEMICAL REACTION

- To know for certain that a chemical reaction has taken place requires evidence that one or more substances have undergone a change in identity.

- Certain easily observed changes usually indicate that a chemical reaction has occurred:
  - Evolution of heat and light
  - Production of a gas
  - Formation of a precipitate
    - **Precipitate**: a solid that is produced as a result of a chemical reaction in solution and that separates from the solution
  - Color change
CHEMICAL EQUATIONS

A + B \rightarrow C + D

Reactants: starting substances in a chemical reaction

Products: the substances formed in a chemical reaction

\[ \text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \]
CHARACTERISTICS OF A CHEMICAL EQUATION

✓ The equation must represent known facts
  ✓ All reactants and products must be identified

✓ The equation must contain the correct formulas for the reactants and products

✓ The law of conservation of mass must be satisfied
LAW OF CONSERVATION OF MASS

- Mass is neither created nor destroyed in a chemical reaction
- Total mass stays the same
- Atoms can only rearrange
WRITING EQUATIONS

1. Identify the substances involved
2. Use symbols to show:
   - How many? – coefficient
     - Coefficient: a small whole number that appears in front of a chemical formula in a chemical equation
   - Of what? – chemical formulas
   - In what state? – physical state
     - Letters in parentheses indicate the physical state of each substance involved in the reaction
       - (g) gas; (l) liquid; (s) solid; (aq) aqueous solution
<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>MEANING</th>
</tr>
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<tbody>
<tr>
<td>➞</td>
<td>produces, forms</td>
</tr>
<tr>
<td>+</td>
<td>plus, and</td>
</tr>
<tr>
<td>(s)</td>
<td>solid</td>
</tr>
<tr>
<td>(l)</td>
<td>liquid</td>
</tr>
<tr>
<td>(g)</td>
<td>gas</td>
</tr>
<tr>
<td>(aq)</td>
<td>aqueous (solid dissolved in water)</td>
</tr>
<tr>
<td>△</td>
<td>the reactants are heated</td>
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</tbody>
</table>
BALANCING CHEMICAL EQUATIONS

① Write the unbalanced chemical equation.
② Count the atoms of each type on each side of the equation.
③ Add coefficients to make the number of atoms equal (Remember: the law of conservation of mass must be satisfied!)
  - Coefficient subscript = # of atoms
④ Reduce coefficients to the lowest possible ratio, if necessary.
⑤ Double check atom balance!
SAMPLE PROBLEM

Translate the following equation and then balance it.
Aluminum and copper (II) chloride react to form copper and aluminum chloride.

\[
\text{Al} + \text{CuCl}_2 \rightarrow \text{Cu} + \text{AlCl}_3
\]

\[
\begin{align*}
\text{Al} & \quad \text{CuCl}_2 & \rightarrow & \quad \text{Cu} & \quad \text{AlCl}_3 \\
2 & \quad 3 & \rightarrow & \quad 3 & \quad 2 \\
2 & \quad 1 & \rightarrow & \quad 1 & \quad 2 \\
3 & \quad 1 & \rightarrow & \quad 1 & \quad 3 \\
6 & \quad 2 & \rightarrow & \quad 3 & \quad 6
\end{align*}
\]
• https://www.learningliftoff.com/high-school-science-learning-activity-balancing-chemical-equations/
Also helpful to know the common diatomic molecules!

- $\text{H}_2 \rightarrow \text{Hydrogen}$
- $\text{N}_2 \rightarrow \text{Nitrogen}$
- $\text{F}_2 \rightarrow \text{Fluorine}$
- $\text{O}_2 \rightarrow \text{Oxygen}$
- $\text{I}_2 \rightarrow \text{Iodine}$
- $\text{Cl}_2 \rightarrow \text{Chlorine}$
- $\text{Br}_2 \rightarrow \text{Bromine}$

Have No Fear Of Ice Cold Bears 😊
YOU TRY!

Balance each of the following chemical reactions:

- Magnesium reacts with oxygen to produce magnesium oxide.
  - $\text{Mg}_\text{(s)} + \text{O}_2\text{(g)} \rightarrow \text{MgO}_\text{(s)}$
  - $2 \text{ Mg} + \text{O}_2 \rightarrow 2 \text{ MgO}$

- Iron (III) combines with oxygen to form iron (III) oxide.
  - $\text{Fe}_\text{(s)} + \text{O}_2\text{(g)} \rightarrow \text{Fe}_2\text{O}_3\text{(s)}$
  - $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$
Practice

+ Balance the following equations:

1. \( \_\_\text{Mg} + \_\_\text{HCl} \rightarrow \_\_\text{MgCl}_2 + \_\_\text{H}_2 \)
2. \( \_\_\text{H}_2 + \_\_\text{Cl}_2 \rightarrow \_\_\text{HCl} \)
3. \( \_\_\text{Ga} + \_\_\text{O}_2 \rightarrow \_\_\text{Ga}_2\text{O}_3 \)
4. \( \_\_\text{Al} + \_\_\text{Fe}_2\text{O}_3 \rightarrow \_\_\text{Al}_2\text{O}_3 + \_\_\text{Fe} \)
5. \( \_\_\text{GeCl}_4 + \_\_\text{H}_2\text{O} \rightarrow \_\_\text{GeO}_2 + \_\_\text{HCl} \)
6. \( \_\_\text{Fe} + \_\_\text{H}_2\text{O} \rightarrow \_\_\text{Fe}_3\text{O}_4 + \_\_\text{H}_2 \)