CHEMICAL REACTIONS

Reactants: Zn + I₂  →  Product: ZnI₂
**Chemical Equations**

Their Job: Depict the kind of **reactants** and **products** and their relative amounts in a reaction.

\[ 4 \text{Al} \,(\text{s}) \,+\, 3\text{O}_2 \,(\text{g}) \,\longrightarrow\, 2\text{Al}_2\text{O}_3 \,(\text{s}) \]

The **numbers in the front** are called **Coefficients**

The letters (s), (g), and (l) are the physical states of compounds.
Chemical Equations

4 Al\text{\,(s)} + 3 \text{O}_2\text{\,(g)} \longrightarrow 2 \text{Al}_2\text{O}_3\text{\,(s)}

\textit{reactants} – Pure substance/s that participates in a Chemical Reaction

\textit{products} – New pure substance/s that are made from \textit{reactants} in a Chemical Reaction
**Introduction**

– Chemical reactions occur when bonds between the outermost parts of atoms are formed or broken.

– Chemical reactions involve changes in matter, the making of new materials with new properties, and energy changes.

– Symbols represent elements, formulas describe compounds, chemical equations describe a chemical reaction.
Parts of a Reaction Equation

- Chemical equations show the conversion of reactants (the molecules shown on the left of the arrow) into products (the molecules shown on the right of the arrow).
  - A + sign separates molecules on the same side.
  - The arrow is read as “yields”.
  - Example
    
    \[ C + O_2 \rightarrow CO_2 \]
  - This reads “carbon plus oxygen react to yield carbon dioxide”
The charcoal used in a grill is basically carbon. The carbon reacts with oxygen to yield carbon dioxide. The chemical equation for this reaction, $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$, contains the same information as the English sentence but has quantitative meaning as well.
Because of the principle of the conservation of matter, an equation must be balanced. It must have the same number of atoms of the same kind on both sides.

Lavoisier, 1788
Symbols Used in Equations

• Solid ___
• Liquid (l)
• Gas ___
• Aqueous solution (aq)
• Catalyst $\text{H}_2\text{SO}_4$
• Escaping gas (↑)
• Change of temperature (Δ)
Balancing Equations

- When balancing a chemical reaction you may add coefficients in front of the compounds to balance the reaction, but you may not change the subscripts.

  - Changing the subscripts changes the compound. Subscripts are determined by the valence electrons (charges for ionic or sharing for covalent)
### Subscripts vs. Coefficients

<table>
<thead>
<tr>
<th>Subscript</th>
<th>Meaning</th>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>means</td>
<td>One atom of carbon</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>means</td>
<td>One atom of oxygen</td>
<td></td>
</tr>
<tr>
<td>O₂</td>
<td>means</td>
<td>One molecule of oxygen consisting of two atoms of oxygen</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>means</td>
<td>One molecule of carbon monoxide consisting of one atom of carbon attached to one atom of oxygen</td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
<td>means</td>
<td>One molecule of carbon dioxide consisting of one atom of carbon attached to two atoms of oxygen</td>
<td></td>
</tr>
<tr>
<td>3 CO₂</td>
<td>means</td>
<td>Three molecules of carbon dioxide, each consisting of one atom of carbon attached to two atoms of oxygen</td>
<td></td>
</tr>
</tbody>
</table>

The **subscripts** tell you how many atoms of a particular element are in a compound. The **coefficient** tells you about the quantity, or number, of molecules of the compound.
Chemical Equations

4 Al(s) + 3 O₂(g)  
---→ 2 Al₂O₃(s)  

This equation means

4 Al atoms + 3 O₂ molecules  
---produces---→  
2 molecules of Al₂O₃
Steps to Balancing Equations

There are four basic steps to balancing a chemical equation.

1. **Write the correct formula for the reactants and the products.** DO NOT TRY TO BALANCE IT YET! You must write the correct formulas first. And most importantly, once you write them correctly DO NOT CHANGE THE FORMULAS!

2. Find the number of atoms for each **element** on the left side. Compare those against the number of the atoms of the same **element** on the right side.

3. Determine where to place **coefficients** in front of formulas so that the left side has the same number of atoms as the right side for EACH element in order to balance the equation.

4. Check your answer to see if:
   - The numbers of atoms on both sides of the equation are now **balanced**.
   - The coefficients are in the lowest whole number ratios. (reduced)
Some Suggestions to Help You

Some Helpful Hints for balancing equations:

• Take one element at a time, working left to right except for H and O. Save H for next to last, and O until last.

• IF everything balances except for O, and there is no way to balance O with a whole number, double all the coefficients and try again.

*(Because O is diatomic as an element)*
<table>
<thead>
<tr>
<th>Reaction:</th>
<th>Methane reacts with oxygen to yield carbon dioxide and water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balanced equation:</td>
<td>( \text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O} )</td>
</tr>
<tr>
<td>Sketches representing molecules:</td>
<td><img src="image1" alt="Methane molecule" /> + <img src="image2" alt="Oxygen molecule" /> → <img src="image3" alt="Carbon dioxide molecule" /> + <img src="image4" alt="Water molecule" /></td>
</tr>
<tr>
<td>Meaning:</td>
<td>1 molecule of methane + 2 molecules of oxygen → 1 molecule of carbon dioxide + 2 molecules of water</td>
</tr>
</tbody>
</table>
Practice Equations

\[ 2\ H_2(g) + \ ____\ O_2(g) \rightarrow 2\ H_2O(l) \]

What Happened to the Other Oxygen Atom?????

This equation is not balanced!

Two hydrogen atoms from a hydrogen molecule \( (H_2) \) combines with one of the oxygen atoms from an oxygen molecule \( (O_2) \) to form \( H_2O \). Then, the remaining oxygen atom combines with two more hydrogen atoms (from another \( H_2 \) molecule) to make a second \( H_2O \) molecule.
Practice Equations

\[ \begin{align*}
2 \text{ Al}(s) & + 3 \text{ Br}_2(l) \rightarrow \text{ Al}_2\text{Br}_6(s) \\
\end{align*} \]
C_3H_8(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)
B_4H_{10}(g) + O_2(g) \rightarrow B_2O_3(g) + H_2O(g)
Sodium phosphate + iron (III) oxide $\rightarrow$ sodium oxide + iron (III) phosphate

$$\text{Na}_3\text{PO}_4 + \text{Fe}_2\text{O}_3 \rightarrow \text{Na}_2\text{O} + \text{FePO}_4$$
For More Practice

http://funbasedlearning.com/chemistry/chemBalancer/default.htm