Lithium has one valence electron.

Helium has two valence electrons.
Oxidation number corresponds to the need for an atom to gain or lose electrons.
Writing a Chemical Formula

Write the formula for a compound that is made of iron (III) and oxygen.

1. Find the oxidation numbers of each element in the compound.

   The oxidation number of iron (III) is 3+. Its formula is Fe$^{3+}$.
   Oxygen has an oxidation number of 2-. Its formula is O$^{2-}$.

2. Determine the ratios of each element and write the chemical formula.

   $3^+ \; 3^+ \; + \; 2^- \; 2^- \; 2^- \; = \; 0$

   If you have two iron (III) ions for every three oxygen ions, what happens? 2(3+) added to 3(2-) is equal to 0. This means that three iron (III) ions bond with two oxygen ions to get a neutral compound.

   The formula for a compound of iron (III) and oxygen is Fe$_2$O$_3$.

An easy way to write a chemical formula:

\[
\begin{array}{c}
\text{Fe} \\
3^+ \\
2 \\
\text{O} \\
2^- \\
3
\end{array}
= \text{Fe}_2\text{O}_3
\]
What does a chemical formula tell you?

lithium nitrate

LiNO₃

1. Number and type of atoms
- 1 lithium atom
- 1 nitrogen atom
- 3 oxygen atoms

2. Type of ions
- Li³⁺
- NO₃⁻

3. Formula mass
- Formula mass = (6.9) + (14.0) + (3 x 16.0) = 68.9 amu
Formula Mass of a Compound

What is the formula mass of calcium carbonate?

Write the chemical formula for the compound.

**chemical formula**: \( \text{CaCO}_3 \)

List the atoms, number of each atom, and atomic mass of each atom.

<table>
<thead>
<tr>
<th>atom</th>
<th>number</th>
<th>atomic mass</th>
<th>total mass (number x atomic mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>1</td>
<td>40.08 amu</td>
<td>40.08</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>12.01 amu</td>
<td>12.01</td>
</tr>
<tr>
<td>O</td>
<td>3</td>
<td>16.00 amu</td>
<td>48.00</td>
</tr>
</tbody>
</table>

Add up the values for each type of atom to calculate the molecular mass.

The molecular mass of calcium carbonate is 100.09 amu.
Predicting the Products of a Reaction

**Copper chloride solution reacts with zinc metal to produce what?**

1. Look up oxidation numbers of elements in compound.
2. Write the chemical formulas for the reactants.
3. Identify the type of reaction.
4. Predict the products. Write chemical formulas for products.
5. Balance equation.

**Copper chloride solution reacts with zinc metal to produce:**

\[
\text{CuCl}_2^{(aq)} + \text{Zn}^{(s)} \rightarrow \text{Cu}^{(s)} + \text{ZnCl}_2^{(aq)}
\]

**Balanced!**
Balancing Chemical Equations

1. Write the chemical equation.

Reactants: HCl + CaCO₃

Products: CaCl₂ + CO₂ + H₂O

2. Count the number of each type of atom on both sides.

<table>
<thead>
<tr>
<th></th>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>[ ]</td>
<td>[X]</td>
</tr>
<tr>
<td>Carbon</td>
<td>[ ]</td>
<td>[✓]</td>
</tr>
<tr>
<td>Oxygen</td>
<td>[ ]</td>
<td>[✓]</td>
</tr>
<tr>
<td>Chlorine</td>
<td>[ ]</td>
<td>[X]</td>
</tr>
<tr>
<td>Calcium</td>
<td>[ ]</td>
<td>[✓]</td>
</tr>
</tbody>
</table>

Missing a Hydrogen atom and a Chlorine atom on the Reactant side. These can only be added as HCl molecule.
3. Add coefficients to balance the equation.

Balancing Chemical Equations

2HCl + CaCO₃ → CaCl₂ + CO₂ + H₂O
Chemical Formulas
Coefficients and Subscripts

A coefficient of 2 in front of methane: \(2\text{CH}_4\) gives you...

- 2 carbon atoms and 8 hydrogen atoms
- enough carbon and hydrogen atoms to make 2 molecules of methane

2 carbon atoms and 8 hydrogen atoms
## The Types of Reactions

<table>
<thead>
<tr>
<th>Type</th>
<th>General equation</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>addition</td>
<td>( A + B \rightarrow AB )</td>
<td>( 2H_2 + O_2 \rightarrow 2H_2O )</td>
</tr>
<tr>
<td></td>
<td>( AB \rightarrow A + B )</td>
<td>( 2NaHCO_3 \rightarrow H_2 + 2NaCO_3 )</td>
</tr>
<tr>
<td></td>
<td>( AX + B \rightarrow BX + A )</td>
<td>( Fe + CuCl_2 \rightarrow FeCl_2 + Cu )</td>
</tr>
<tr>
<td></td>
<td>( AB + CD \rightarrow AD + CB )</td>
<td>( Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3 )</td>
</tr>
<tr>
<td>decomposition</td>
<td>( A + B \rightarrow AB )</td>
<td>( C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O )</td>
</tr>
<tr>
<td>single-displacement</td>
<td>( AX + B \rightarrow BX + A )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( AB + CD \rightarrow AD + CB )</td>
<td></td>
</tr>
<tr>
<td>double-displacement</td>
<td>( AB \rightarrow A + B )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( AX + B \rightarrow BX + A )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( AB + CD \rightarrow AD + CB )</td>
<td></td>
</tr>
<tr>
<td>combustion</td>
<td>( C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O )</td>
<td></td>
</tr>
</tbody>
</table>
Fission

Fission can be started when a neutron bombards a nucleus. A chain reaction results.

Step A
A free neutron bombards a nucleus.

Step B
The nucleus splits.

Step C
The splitting nucleus releases more neutrons. These neutrons bombard other nuclei.

Legend
○ = neutron
○ = nucleus
In fusion, light nuclei are fused into heavier nuclei, releasing a lot of energy.

The fusion of hydrogen-3 (1 proton + 2 neutrons) with hydrogen-2 (1 proton + 1 neutron) produces a helium nucleus, a neutron, and energy.
Nuclear Decay

**Alpha decay**
- Protons decrease by 2
- Neutrons decrease by 2
- Released: An alpha particle and energy

**Beta decay**
- Protons decrease by 1
- Neutrons decrease by 1
- Released: An electron and energy

**Gamma decay**
- Released: A gamma ray (high energy electromagnetic radiation)

<table>
<thead>
<tr>
<th>Protons</th>
<th>Decrease by 2</th>
<th>Increase by 1</th>
<th>Unchanged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrons</td>
<td>Decrease by 2</td>
<td>Decrease by 1</td>
<td>Unchanged</td>
</tr>
</tbody>
</table>

What is released?

- An alpha particle and energy
- An electron and energy
- A gamma ray (high energy electromagnetic radiation)
Carbon Reactions

What connections do you see between combustion and photosynthesis?

Combustion of fuel

Emissions

CO₂
CO
NO
NO₂
H₂O

FUEL

AIR

O₂ N₂

Water and carbon dioxide are reactants in photosynthesis.

Glucose and oxygen are products in photosynthesis.

Combustion of fuel and photosynthesis are both carbon reactions, involving the transfer of energy and the recycling of carbon. In combustion, fuel reacts with oxygen to produce carbon dioxide, water, and other emissions. In photosynthesis, carbon dioxide and water are converted into glucose and oxygen, utilizing sunlight as energy. Both processes are crucial for the carbon cycle and the production of energy in the environment.
How Trees Help the Environment

What can 1 acre of trees do every day?

SO₂ 6 lbs
O₂
NO₂ 9 lbs
CO₂ 100 lbs
CO 0.5 lbs
Particulates 48 lbs
NO₂ 9 lbs
Some of the solar radiation that reaches Earth is absorbed by its surface, and some is reflected and exits the atmosphere. However, heat that builds up within the Earth's atmosphere is trapped by global warming gases. The main global warming gases are carbon dioxide ($CO_2$), methane, ($CH_4$) and nitrous oxide ($N_2O$).