Chemistry

CHEMISTRY NOTES

Atom- • The building blocks of matter
• Made of protons, neutrons and electrons.

Element- Pure substances that cannot be separated.
Ex: Gold

Compound- 2 or more elements bonded together
Ex: CO₂

Molecule- Smallest part of a compound that still has the same properties

Example:
Hydrogen (H) and Oxygen (O) are **Elements**.

When 2 **atoms** of hydrogen and 1 atom of oxygen combine they form 1 **molecule** of the **compound** water (H₂O).
**SUBATOMIC PARTICLES**

Atoms are made up of 3 subatomic particles. In the nucleus (core or center of the atom) there are 2 particles.

1. **Protons** - Subatomic particles with a **+** charge.

2. **Neutrons** - Subatomic particles with a **Neutral** charge, or **No** charge.

The 3rd subatomic particle orbits (flies around) the nucleus.

3. **Electron** - Subatomic particles with a **Negative** charge.

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**THE PERIODIC TABLE**

Developed by **Mendelev** in the 1800s.

1) Lists all of the **Elements**.

2) From left to right the elements are listed in **increasing** atomic number.

3) The rows (Horizontal) are called **periods**. (Get it? Like PERIODic table!) All these elements have the same amount of electron shells. (Which we will discuss later.)

4) Columns (Vertical) are called **groups or families**. Elements in the same group have similar properties.

Symbols- either 1 capital letter or 1 capital letter combined with a lowercase.

ex: Hydrogen- **H**  
Helium **He**
**USING THE PERIODIC TABLE**

*The periodic table contains 2 main numbers*

1) The **Atomic Number** - the number of __**Protons**__ in an atom.
   - This determines what element it is.
   - No two elements have the same atomic number.
   - Because atoms are neutral it is also the number of __**Electrons**__.

2) **Atomic Mass** - the total number of __**Protons**__ & __**Neutrons**__ in an atom.
   - Basically the total mass of an atom.

**Mass of an atom**
- Because atoms are so small, scientists had to create a new unit to measure their mass.
  The __**Atomic Mass Unit**__ or AMU.
In this system the mass of a

<table>
<thead>
<tr>
<th>Proton</th>
<th>Neutron</th>
<th>Electron</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 AMU</td>
<td>1 AMU</td>
<td>0 AMU</td>
</tr>
</tbody>
</table>

To find the number of protons, neutrons, electrons:
1) The # of protons = the atomic number
2) The # of electrons = the atomic number
3) The # of neutrons = Round the atomic mass, then - atomic #
Why aren’t atomic masses whole numbers?

**Answer:**
Atoms come in different forms. These different forms are called isotopes. The atomic mass is an average of these atoms.

**Isotopes:** Atoms of the same element that have a different number of neutrons.

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**ISOTOPES OF CARBON**

- Carbon-12: stable
- Carbon-13: stable
- Carbon-14: unstable (radioactive)

- **Proton**
- **Neutron**
- **Electron**
More Practice

K
Symbol: K  
Name: Potassium  
Atomic number: 19  
Atomic mass: 39  
# protons: 19  
# neutrons: 20  
# electrons: 19

Al
Symbol: Al  
Name: Aluminum  
Atomic number: 13  
Atomic mass: 27  
# protons: 13  
# neutrons: 14  
# electrons: 13

Br
Symbol: Br  
Name: Bromine  
Atomic number: 35  
Atomic mass: 80  
# protons: 35  
# neutrons: 45  
# electrons: 35

Drawing Atoms

1. Calculate the # of p, e & n  
2. Draw a circle for the nucleus  
3. Inside the nucleus write the number of protons and neutrons.  
4. Draw a circle around the nucleus for each electron shell.  
5. Fill in the amount of electrons for each orbit.
Drawing Atoms (Electron Dot Diagrams)

1. Write the element’s symbol.
2. Put dots on each side of the symbol to represent the outer shell.
3. Begin on the top - right - bottom - left then back to the top.

Aluminum: Al
Flourine: F
Magnesium: Mg

Compound Notes

4H₂O  

- **Compound-**: 2 or more elements joined together
- **Coefficient-**: # of molecules
- **Subscript-**: How many atoms of an element there are

Subscripts and coefficients making equations easier & neater.

Rewrite 4H₂O without a coefficient: H₂O H₂O H₂O H₂O

Rewrite 4H₂O without a subscript: 4H₂O
Breaking Down a Compound

Ex: $\text{Al}_2\text{O}_3$

1. List the elements.
2. How many molecules are listed?
3. Determine the total # of atoms of each element.

<table>
<thead>
<tr>
<th># Molecules</th>
<th># Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td>1</td>
</tr>
<tr>
<td>O</td>
<td>1</td>
</tr>
</tbody>
</table>

Parentheses: $(\text{NO}_3)_3$
- 1st subscript is applied to ___ oxygen only ___
- 2nd Subscript is applied to ___ The entire molecule ___

Ex: $3\text{H}_2(\text{CO}_3)_3$
1. List the elements.
2. How many molecules are listed?
3. Determine the total # of atoms for each element

<table>
<thead>
<tr>
<th>#Molecules</th>
<th># Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>3</td>
</tr>
</tbody>
</table>
I know how much atoms weigh but, what about Compounds?

1. Fill in the "symbols" column (b)
2. Fill in the amount of molecules (c)
3. Fill in the # of atoms (d)
4. Look up the atomic mass using your periodic table and place it in column (e)
5. Multiply the # of atoms by their atomic mass (f)
6. Add the atomic masses together to get the total molecular mass (g)

<table>
<thead>
<tr>
<th>(a) Compound</th>
<th>(b) Symbol</th>
<th>(c) # Molecules</th>
<th>(d) # atoms</th>
<th>(e) Atomic Mass</th>
<th>(f) Total Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na(NO₃)</td>
<td>NaNO</td>
<td>1</td>
<td>1</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>HCl</td>
<td>HCl</td>
<td>1</td>
<td>1</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>CO₂</td>
<td>CO</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>4C₁₂H₂₂O₁₁</td>
<td>CΗO</td>
<td>4</td>
<td>48 88 44</td>
<td>12 1 16</td>
<td>576 88 704</td>
</tr>
<tr>
<td>6H₂SO₄</td>
<td>HSO</td>
<td>6</td>
<td>12 6 24</td>
<td>1 32 16</td>
<td>12 192 384</td>
</tr>
<tr>
<td>3Ni(ClO₃)₃</td>
<td>NiClO</td>
<td>3</td>
<td>3 9 27</td>
<td>59 35 16</td>
<td>177 315 432</td>
</tr>
</tbody>
</table>
HOW COMPOUNDS ARE MADE

All atoms want 1 thing..... to be Stable.

STABLE is having 8 electrons in the outermost shell. Atoms can accomplish this by gaining or losing electrons.

**OCTET RULE**: Atoms will form compounds to reach eight electrons in their outer energy level.
• Atoms with less than 4 electrons in their outer level tend to lose electrons to form compounds.
• Atoms with more than 4 electrons in their outer level tend to gain electrons to form compounds.

Electrons in the outermost shell are known as Valence Electrons.

All Members of a group have the same Valence number!

Valence Electrons are the electrons found in the Outermost shell.
Sodium has \(1\) valence electron.

Sodium’s oxidation number is \(+1\).
- Sodium can have 8 electrons in its outer shell if it loses (lends) an electron.

Chlorine has \(7\) valence electrons.

Chlorine’s oxidation number is \(-1\).
The \(-1\) means sodium wants to gain (borrow) one electron than have 8 electrons in its outer shell.

Carbon has \(4\) valence electrons.

Carbon’s oxidation number is \(+4\) or \(-4\).

Gallium has \(3\) valence electrons.

Gallium’s oxidation number is \(+3\). It has 3 extra electrons to lose to become stable.
Using your Periodic Table fill in the chart.

<table>
<thead>
<tr>
<th>Element</th>
<th>Valence Electrons</th>
<th>Oxidation Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>1</td>
<td>+1</td>
</tr>
<tr>
<td>Calcium</td>
<td>2</td>
<td>+2</td>
</tr>
<tr>
<td>Lead</td>
<td>4</td>
<td>+4 / -4</td>
</tr>
<tr>
<td>Krypton</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>5</td>
<td>-3</td>
</tr>
<tr>
<td>Zinc</td>
<td>2</td>
<td>+2</td>
</tr>
<tr>
<td>Lithium</td>
<td>1</td>
<td>+1</td>
</tr>
<tr>
<td>Manganese</td>
<td>2</td>
<td>+2</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>5</td>
<td>-3</td>
</tr>
<tr>
<td>Silicon</td>
<td>4</td>
<td>+4 / -4</td>
</tr>
<tr>
<td>Sulfur</td>
<td>6</td>
<td>-2</td>
</tr>
<tr>
<td>Barium</td>
<td>2</td>
<td>+2</td>
</tr>
<tr>
<td>Nickel</td>
<td>2</td>
<td>+2</td>
</tr>
<tr>
<td>Copper</td>
<td>1</td>
<td>+1</td>
</tr>
</tbody>
</table>
Forming Compounds

Water’s formula is always H\(_2\)O because H has 1 electron to lose, but Oxygen needs 2 electrons. So 2 H’s each share 1 electron with Oxygen!

\[ H^+ + H^+ + O^{-2} = \text{total net charge of 0} \]

We use the criss-cross method as a short cut to determine the chemical formula for a compound. Here are the steps:

1. Write down the oxidation numbers. Metals are always written on the left and nonmetals on the right.

2. Criss-cross the oxidation numbers to make them the new subscript for the element.

Ex:

\[ H \quad O \quad 2 \quad 1 \]

3. Write the formula = \( H_2O_1 \)

4. Reduce or rewrite the formula. (1 is not written) \( H_2O \)
Determining compound formulas

1. Write the symbol of the metal on the left and the nonmetal on the right.
2. Find the oxidation number on the periodic table.
3. Criss-cross the oxidation numbers, drop the sign.
4. Do not write ones.

Examples:
Sodium and Phosphorus

\[
\begin{align*}
\text{Na}^+ & \quad \text{P}^- \\
\text{Na}_3\text{P} & \\
\end{align*}
\]

Calcium and Sulfur

\[
\begin{align*}
\text{Ca}^{+2} & \quad \text{S}^{-2} \\
\text{CaS} & \\
\end{align*}
\]

Practice forming compounds

1. Beryllium + Fluorine

\[
\begin{align*}
\text{Be}^{+2} & \quad \text{F}^{-1} \\
\text{BeF}_2 & \end{align*}
\]

2. Magnesium + Oxygen

\[
\begin{align*}
\text{Mg}^{+2} & \quad \text{O}^{-2} \\
\text{Mg}_2\text{O}_2 & \\
\text{MgO} & \\
\end{align*}
\]

3. Barium + Chlorine

\[
\begin{align*}
\text{Ba}^{+2} & \quad \text{Cl}^{-1} \\
\text{BaCl}_2 & \\
\end{align*}
\]
Metals vs. Nonmetals

<table>
<thead>
<tr>
<th>Metals</th>
<th>Nonmetals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 4 electrons in outermost shell</td>
<td>More than 4 electrons in outermost shell</td>
</tr>
<tr>
<td>Wants to lose extra electrons</td>
<td>Wants to gain electrons to fill outermost shell</td>
</tr>
<tr>
<td>Has a + oxidation #</td>
<td>Has a - oxidation #</td>
</tr>
<tr>
<td>Are malleable and ductile</td>
<td>Are brittle</td>
</tr>
</tbody>
</table>

Metals usually link up with nonmetals to form compounds.

**Metalliioids** - properties of both metals and nonmetals found along the “stair-step” Ex: B, Si, As, Ge, Sb, Te, At
Radicals

- Radical: A group of atoms that act like a single atom.
  - Radicals always act like one atom. They have their own oxidation number. You can look these up on your list.
  - Radicals can form compounds, use the same steps to determine the formula. Just keep the radical in the parenthesis ()

Examples:

- Ni\(\text{(PO}_4\text{)}\)
- (NH\(_4\text{)}\_2\text{(CO}_3\text{)}\)

\(\text{Ni}^{+2}\text{ (PO}_4\text{)}^{-3}\text{ (NH}_4\text{)}^{+1}\text{ (CO}_3\text{)}^{-2}\)

\(\text{Ni}_3\text{(PO}_4\text{)}_2\) (NH\(_4\text{)}_2\text{(CO}_3\text{)}\)

Periodic Table of the Elements

*KEY: Atomic Mase
Atomic Number
Electron shell*
<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Valence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium</td>
<td>NH₄⁺</td>
<td>+1</td>
</tr>
<tr>
<td>Perchlorate</td>
<td>ClO₄⁻</td>
<td>-1</td>
</tr>
<tr>
<td>Chlorate</td>
<td>ClO₃⁻</td>
<td>-1</td>
</tr>
<tr>
<td>Chlorite</td>
<td>ClO₂⁻</td>
<td>-1</td>
</tr>
<tr>
<td>Nitrate</td>
<td>NO₃⁻</td>
<td>-1</td>
</tr>
<tr>
<td>Nitrite</td>
<td>NO₂⁻</td>
<td>-1</td>
</tr>
<tr>
<td>Acetate</td>
<td>C₂H₃O₂⁻</td>
<td>-1</td>
</tr>
<tr>
<td>Permanate</td>
<td>MnO₄⁻</td>
<td>-1</td>
</tr>
<tr>
<td>Hydroxide</td>
<td>OH⁻</td>
<td>-1</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>HCO₃⁻</td>
<td>-1</td>
</tr>
<tr>
<td>Carbonate</td>
<td>CO₃⁻</td>
<td>-2</td>
</tr>
<tr>
<td>Sulfate</td>
<td>SO₄⁻</td>
<td>-2</td>
</tr>
<tr>
<td>Sulfite</td>
<td>SO₃⁻</td>
<td>-2</td>
</tr>
<tr>
<td>Chromate</td>
<td>CrO₄⁻</td>
<td>-2</td>
</tr>
<tr>
<td>Dichromate</td>
<td>Cr₂O₇⁻</td>
<td>-2</td>
</tr>
<tr>
<td>Silicate</td>
<td>SiO₃⁻</td>
<td>-2</td>
</tr>
<tr>
<td>Peroxide</td>
<td>O₂⁻</td>
<td>-2</td>
</tr>
<tr>
<td>Borate</td>
<td>BO₃⁻</td>
<td>-3</td>
</tr>
<tr>
<td>Phosphate</td>
<td>PO₄⁻</td>
<td>-3</td>
</tr>
<tr>
<td>Phosphite</td>
<td>PO₃⁻</td>
<td>-3</td>
</tr>
<tr>
<td>Arsenate</td>
<td>AsO₄⁻</td>
<td>-3</td>
</tr>
</tbody>
</table>