<table>
<thead>
<tr>
<th>Big Ideas in the packet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Naming Chemical Formulas</strong></td>
</tr>
<tr>
<td>Counting atoms</td>
</tr>
<tr>
<td>Subscript and coefficient</td>
</tr>
<tr>
<td>What goes in must come out:</td>
</tr>
<tr>
<td>A balancing activity</td>
</tr>
<tr>
<td>Types of reactions</td>
</tr>
<tr>
<td>Reaction rate</td>
</tr>
</tbody>
</table>
NAMING CHEMICAL COMPOUNDS

Now that you know how to write the formulas of compounds, you need to know how to NAME them. If you follow these guidelines and use the oxidation numbers on the back of your periodic table, you should start to see a pattern in how to name them.

### Rule 1 – Metal and Non-Metal, No Polyatomic Ions:

If a metal and a non-metal are combining and there are no polyatomic ions in the formula, (example 1: BeCl₂)

1. Name the **metal** (the + element): $\text{BeCl}_2 = \text{beryllium}$
2. Name the **base** of the non-metal (the - element): $\text{BeCl}_2 = \text{“chlor”}$
3. Add the ending **–ide** to the non-metal: $\text{BeCl}_2 = \text{chloride}$

\[
\text{BeCl}_2 = \text{beryllium chloride}
\]

Example 2: $\text{Al}_2\text{S}_3 = \text{aluminum} + \text{sulf} + \text{ide} = \text{aluminum sulfide}$

**Note:** Certain metals such as copper, iron, or chromium, have more than one type of ion. (Example: iron (II), iron (III) etc.) Therefore, you need to tell which one is in the compound you’re naming. **Look at the subscript (small #) of the 2\text{nd} element. That subscript will be the oxidation number (roman numeral) of the first element.**

\[
\begin{align*}
\text{FeCl}_2 & = \text{iron (II) chloride} \\
\text{FeCl}_3 & = \text{iron (III) chloride} \\
\text{CuCl} & = \text{copper (I) chloride}
\end{align*}
\]

### Now, practice with these compounds:

#### Rule 1

1. MgO
2. CaI₂
3. NaCl
4. AuO
5. Cr₂O₃
6. Mn₃N₂
7. Potassium Phosphide
8. Zinc Bromide
9. Mercury II Iodide
10. Aluminium Oxide
**Rule 2 – Metal and Polyatomic Ion:**
If you have a **metal** combined with a **polyatomic ion** (one of the italicized ions from your oxidation number table) then:

1. Name the **element** in the metal (+) position.
2. Name the **polyatomic** (-) ion.

**Examples:**

\[
\begin{align*}
\text{Na}_2\text{CO}_3 &= \text{sodium carbonate} \\
\text{Ca}_3\text{(PO}_4\text{)}_2 &= \text{calcium phosphate} \\
\text{AgNO}_3 &= \text{silver nitrate}
\end{align*}
\]

**Rule 2**

1. Na(NO₃)
2. Ni(ClO₃)₂
3. Cu(NO₃)₂
4. (NH₄)P
5. Ba(Cr₂O₇)
6. Zn(C₂H₃O₂)₂
7. Silver hydroxide
8. Ammonium Acetate
9. Iron III sulfate
10. Lead phosphate
Rule 3 – Two Non-Metals:

If **two non-meta**ls have combined into a compound (remember where to find non-metals on the periodic table?)

1. **Name** the non-metal that’s in the first (+) position.
2. Use a **prefix** to indicate how many atoms there are of the second (-) element.
3. Name the base of the second (-) non-metal
4. Add the –ide ending.

<table>
<thead>
<tr>
<th>Prefixes:</th>
<th>Examples:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = mono</td>
<td>CO = carbon + mono + ox + ide = carbon monoxide</td>
</tr>
<tr>
<td>2 = di</td>
<td>CO₂ = carbon + di + ox + ide = carbon dioxide</td>
</tr>
<tr>
<td>3 = tri</td>
<td>CCl₄ = carbon + tetra + chlor + ide = carbon tetrachloride</td>
</tr>
<tr>
<td>4 = tetra</td>
<td></td>
</tr>
<tr>
<td>5 = penta</td>
<td></td>
</tr>
<tr>
<td>6 = hexa</td>
<td></td>
</tr>
<tr>
<td>7 = hepta</td>
<td></td>
</tr>
</tbody>
</table>

**Rule 3**

1. SO₂
2. CO₂
3. CF₄
4. CO₇
5. NF₃
6. carbon monofluoride
7. carbon trichloride
8. silicon hexaoxide
A visual for naming compounds

You might want to use the following concept map that summarizes all three rules for naming compounds. You could also create your own concept map.

**Metal + Non-Metal**

Name of element

Specify with roman number which ion for:
- Cu I or Cu II
- Fe II or Fe III
- Cr II or Cr III

One type of atom
Name the anion

*Base + ide*

**Polyatomic**

(more than one type of atom)

*Look for name in the table for common oxidation numbers*

**Non-metal + non-metal**

Name of element

Specify number of anion atoms:
- mono
- di
- tri
- tetra
- penta
- hexa

Name the anion

*Base + ide*
# Naming Chemical Compounds—More Practice

For the following problems identify the rule you need to follow and write the appropriate name or chemical formula.

<p>| | | | | | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>K₃N</td>
<td>Rule:</td>
<td>Name:</td>
<td>9.</td>
<td>Cl₂</td>
<td>Rule:</td>
<td>Name:</td>
<td>16.</td>
<td>Cu₃(PO₄)₂</td>
<td>Rule:</td>
<td>Name:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Fe₂(CO₃)₃</td>
<td>Rule:</td>
<td>Name:</td>
<td>10.</td>
<td>Pb(C₂H₃O₂)₂</td>
<td>Rule:</td>
<td>Name:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Sn(Cr₂O₇)</td>
<td>Rule:</td>
<td>Name:</td>
<td>11.</td>
<td>BaCl₂</td>
<td>Rule:</td>
<td>Name:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>(NH₄)₂(SO₄)</td>
<td>Rule:</td>
<td>Name:</td>
<td>12.</td>
<td>Cs₃P₂</td>
<td>Rule:</td>
<td>Name:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Ag₂(SO₃)</td>
<td>Rule:</td>
<td>Name:</td>
<td>13.</td>
<td>Sr(NO₂)₂</td>
<td>Rule:</td>
<td>Name:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>NO₃</td>
<td>Rule:</td>
<td>Name:</td>
<td>14.</td>
<td>Cr(SO₄)</td>
<td>Rule:</td>
<td>Name:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Li(OH)</td>
<td>Rule:</td>
<td>Name:</td>
<td>15.</td>
<td>Zn₃(PO₄)₂</td>
<td>Rule:</td>
<td>Name:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Subscripts and Coefficients

We have been looking at chemical formulas for compounds. We will now look at chemical formulas for reactions. Look at the following chemical formula written for water:

3H₂O

1. What does the number 3 tell you? ____________________________________________

2. What does the number 2 tell you? ____________________________________________

3. Draw your interpretation of the formula. Use a circle for every atom that you draw, and label the circle with the atomic symbol of the element. Connect with lines the atoms in the same molecule:

4. There are ______ atoms of oxygen and ______ of hydrogen in the formula

There are two important numbers to consider when writing chemical formulas:

- **Subscript**: is the small number written below the lower right side of an element. The subscript indicates the number of atoms of a given element present in one molecule.

  A. H₂O → 2 atoms of H and one atom of O in one molecule H₂O

  B. CO₂ → 1 atom of C and 2 atoms of O in one molecule CO₂.

  Draw the formula:

C. Mg₃P₂ → ___ atoms of Mg and ___ atoms of P in one molecule of Mg₃P₂

  Draw the formula:
Coefficient: is the big number in front of a pure substance (compound or element) that tells us the number of molecules of a compound, or the number of atoms of a single element. For example:

A. 4 C → 4 atoms of carbon (not connected).

B. 2 NaCl → 2 molecules of NaCl. 2 atoms of Na and 2 atoms of Cl.

C. 3 H₂O → ___ molecules of H₂O. 6 atoms of H and 3 atoms of O.

D. 2Be₃As₂ → ___ molecules of Be₃As₂. ___ atoms of Be and ___ of As

Based on your results, how do you know the number of atoms of a certain element if both, the coefficient and the subscripts are present? You multiply them!

What do you think you will need to do if you want to know the number of atoms for a particular element in a formula that has a polyatomic ion? Try this one:

Magnesium phosphate: 3Mg₃(PO₄)₂

Explain here how do you think you could figure out the number of atoms for a particular element:

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

Has ____ molecules for a total of ____ atoms of magnesium, ____ atoms of phosphorus and ____ of oxygen.
To find the number of atoms of oxygen, you need to multiply the coefficient by the subscript for the element, and then by the subscript for the polyatomic ion when applicable (the subscript for the polyatomic is the subscript outside of the parenthesis). For example, for \(3\text{Mg}(\text{PO}_4)_2\):

- Coefficient: 3
- Subscript for oxygen: 4
- Parenthesis subscript: 2

\[3 \times 4 \times 2 = 24 \text{ atoms of oxygen}\]

Let us do this in a table. For all elements in \(3\text{Mg}(\text{PO}_4)_2\):

<table>
<thead>
<tr>
<th>Element</th>
<th>Coefficient</th>
<th>Element subscript</th>
<th>Polyatomic subscript</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mg</td>
<td>3</td>
<td>3</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>P</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>O</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>24</td>
</tr>
</tbody>
</table>

Find the number of atoms for each element in the following formulas:

1. \(6\text{Al}_2\text{S}_3\)

<table>
<thead>
<tr>
<th>Element</th>
<th>Coefficient</th>
<th>Element subscript</th>
<th>Polyatomic subscript</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. \(9\text{B}_2(\text{SO}_4)_3\)

<table>
<thead>
<tr>
<th>Element</th>
<th>Coefficient</th>
<th>Element subscript</th>
<th>Polyatomic subscript</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. \(7(\text{NH})_2(\text{NO}_3)\) Be careful with the Nitrogen atoms for this one!

<table>
<thead>
<tr>
<th>Element</th>
<th>Coefficient</th>
<th>Element subscript</th>
<th>Polyatomic subscript</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Counting atoms when adding formulas. Fill in the table and pay attention to the + sign.

<table>
<thead>
<tr>
<th>Atoms</th>
<th>Name(s) of atoms/compounds</th>
<th>Drawing</th>
<th>Number of Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na</td>
<td>Sodium</td>
<td>[Na]</td>
<td>1</td>
</tr>
<tr>
<td>2 Na</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na + O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Na + O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na₂O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Na₂O</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Explore the Elements—Computer Activity

1) Type in this internet address:  [http://www.webelements.com](http://www.webelements.com)

2) Go to the periodic table and **click on any element symbol** you choose.

3) **Find the following information** about the element that you chose and write it in the appropriate place on the chart.

4) **Go to one of the other web sites listed below** and look for the same information. If you find something different on that website, include it on the chart.

Other websites you may look at:

- "The Visual Elements Periodic Table
  [http://www.chemsoc.org/viselements/pages/pertable_j.html](http://www.chemsoc.org/viselements/pages/pertable_j.html)

- "The Periodic Table of Comic Books
  [http://www.uky.edu/Projects/Chemcomics/](http://www.uky.edu/Projects/Chemcomics/)

- "Environmental Chemistry
  [http://environmentalchemistry.com/vogi/periodic/As.html#Names](http://environmentalchemistry.com/vogi/periodic/As.html#Names)

- "The Chemical Elements

- "Discovery and the Origins of their Names

- "A Periodic Table of the Elements at Los Alamo
  [http://pearl1.lanl.gov/periodic/default.htm](http://pearl1.lanl.gov/periodic/default.htm)

<table>
<thead>
<tr>
<th>Element #</th>
<th>Element #</th>
<th>Element #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element name &amp; symbol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discoverer &amp; Year of discovery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atomic Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where it is found/made</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other interesting facts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What goes in Must Come Out—a balancing activity

We can represent the atoms and compounds that take part in chemical reactions by writing them out in a chemical equation. In a chemical reaction, the atoms and compounds you start with are called reactants, and are written to the left of the reaction arrow. The products are always written on the right side of the arrow and show what was produced in the reaction.

We say an equation is balanced when all the atoms of the reactants on the left side of the arrow are equal to the numbers of atoms in the products on the right side of the arrow.

For example: \[ \text{2Na} + \text{Cl}_2 \rightarrow \text{2NaCl} \]

When reading the reaction equation, we say, “yields” when we come to an arrow. Remember that the big number 2 in front of the Na on the reactant side is known as a coefficient, and means that there are 2 atoms of Na. The big 2 coefficient in front of NaCl on the product side means that there are 2 molecules of NaCl produced, and each molecule is made of one atom of Na and one atom of Cl, for a total of 2 atoms of each. Notice then that there are 2 atoms of Na and 2 atoms of Cl on each side of the equation. This equation is balanced.

In this activity, you will build reactants out of wooden balls and represent the bonds between atoms and ions with wooden bars. (Make sure to use a separate color of ball for each different atom you need). You will then determine the number of products you can produce from your reactants you built. Remember, each reactant must be accounted for as a product, because matter is not created, nor is it destroyed in a reaction.

<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZnCl(_2) + H(_2)</td>
<td>__ HCl + __ Zn</td>
</tr>
</tbody>
</table>

Balanced Equation:

Equation in words:
### Reaction 1

<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 KCl + Br₂</td>
<td>__ KBr + __ Cl₂</td>
</tr>
</tbody>
</table>

**Drawing**

**Balanced Equation:**

**Equation in words:**

---

### Reaction 2

<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>F₂ + 2 NaCl</td>
<td>__ NaF + __ Cl₂</td>
</tr>
</tbody>
</table>

**Drawing**

**Balanced Equation:**

**Equation in words:**

---
<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 H₂O</td>
<td>__ H₂ + __ O₂</td>
</tr>
<tr>
<td>Drawing</td>
<td>Drawing</td>
</tr>
</tbody>
</table>

**Balanced Equation:**

<table>
<thead>
<tr>
<th>Balanced Equation:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Equation in words:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 HgO</td>
<td>__ Hg + __ O₂</td>
</tr>
<tr>
<td>Drawing</td>
<td>Drawing</td>
</tr>
</tbody>
</table>

**Balanced Equation:**

<table>
<thead>
<tr>
<th>Balanced Equation:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Equation in words:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
 IPS – Balancing Chemical Equations Practice

This sheet will help you practice how to balance chemical equations. Remember that when you are balancing a reaction, **you can only write a coefficient in front of the compound or atom** to show that you have more than one of them. Do not try to place a subscript in between atoms of a compound!

**For Example:** The equation \[ \text{Al} + \text{CuCl}_2 \rightarrow \text{AlCl}_3 + \text{Cu} \] is not balanced.

Right now there are three different kinds of atoms in this equation. Check the table below to see how many reactants and products there are:

<table>
<thead>
<tr>
<th>Number of atoms on the Reactant Side</th>
<th>Elements</th>
<th>Number of atoms on the Product Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Al</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Cu</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Cl</td>
<td>3</td>
</tr>
</tbody>
</table>

You should notice that there are **unequal numbers of the Cl atom** on each side of the arrow. Therefore, you need to put a **coefficient** in front of the compounds to get the Cl to be equal on both sides. In this case, we will use a 3 on the left and a 2 on the right so that when these are multiplied by the coefficient, there will be a total of 6 atoms of Cl on each side.

\[ \text{Al} + 3\text{CuCl}_2 \rightarrow 2\text{AlCl}_3 + \text{Cu} \]

Notice that now the Cl atoms are equal, but the coefficients changed the amounts of aluminum (Al) and copper (Cu) on both sides. If we check amounts now, we have:

<table>
<thead>
<tr>
<th>Number of atoms on the Reactant Side</th>
<th>Elements</th>
<th>Number of atoms on the Product Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Al</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Cu</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Cl</td>
<td>6</td>
</tr>
</tbody>
</table>

Finally, put coefficients in front of the Al and Cu atoms to get them to be equal. So overall the balanced equation looks like this:

\[ 2\text{Al} + 3\text{CuCl}_2 \rightarrow 2\text{AlCl}_3 + 3\text{Cu} \]

All reactants and products are balanced!

Using the method you did with the marshmallows, draw the reactants and products for each of the problems on the next page and figure out how many of each product you will get in the end. This time, you will not have marshmallows so just **use labeled circles to represent the atoms** and write the balanced equation in the end. **Remember, use coefficients to balance!**
## Practice Balancing Chemical Equations

### Reactants vs. Products

<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>4Fe + 3O₂</td>
<td>Fe₂O₃</td>
</tr>
</tbody>
</table>

**Number of Atoms:**

- **Reactants:** Fe _____, O _____
- **Products:** Fe _____, O _____

**Balanced Equation:**

| Fe + O → Fe₂O₃ |

**Equation in words:**

- Fe is combined with O to form Fe₂O₃.

---

<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>2CuO₂</td>
<td>Cu + O₂</td>
</tr>
</tbody>
</table>

**Number of Atoms:**

- **Reactants:** Cu _____, O _____
- **Products:** Cu _____, O _____

**Balanced Equation:**

| 2CuO₂ → 2Cu + O₂ |

**Equation in words:**

- Copper (II) oxide (CuO₂) decomposes into copper (Cu) and oxygen (O₂).
<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl₂ + 2KBr</td>
<td>_____ KCl + _____ Br₂</td>
</tr>
</tbody>
</table>

Number of Atoms:
- Cl ______
- K ______
- Br ______

Balanced Equation:

Equation in words:

<table>
<thead>
<tr>
<th>Reactants</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mg(OH)₂ + 2 HCl</td>
<td>_____ H₂O + _____ MgCl₂</td>
</tr>
</tbody>
</table>

Number of Atoms:
- Mg ______
- O ______
- H ______
- Cl ______

Balanced Equation:

Equation in words:
Use coefficients to balance the reactants and products on each side of the arrow in the following equations:

1) \[ \text{_____F}_2 + \text{_____NaCl} \rightarrow \text{_____NaF} + \text{_____Cl}_2 \]

2) \[ \text{_____K(ClO}_3) \rightarrow \text{_____KCl} + \text{_____O}_2 \]

3) \[ \text{_____U} + \text{_____F}_2 \rightarrow \text{_____UF}_6 \]

4) \[ \text{_____CaO} + \text{_____SO}_2 \rightarrow \text{_____Ca(SO}_3) \]

5) \[ \text{_____ (CH}_3\text{)(OH)} \rightarrow \text{_____CO} + \text{_____H}_2 \]

6) \[ \text{_____Al} + \text{_____Pb(NO}_3\text{)}_2 \rightarrow \text{_____Pb} + \text{_____Al(NO}_3\text{)}_3 \]
IPS - Chemical Change Lab - Five Fabulous Reactions!

Purpose: To make observations about what happens when different chemicals are combined.

Materials and Procedure: Students will work in lab groups and rotate from one station to another and follow the instructions at each station. Observations and data should be recorded in the data table below.

Lab Basics
1. Wearing safety goggles (on your eyes) the entire time you are in the lab area is required! The chemicals you are working with are dangerous to your eyes!

2. No horseplay whatsoever will be tolerated! This is your only warning.

3. Tie long hair back—we will be using fire and don’t want your hair to become part of the reactions!

4. Wash all glassware before and after using it. Then return it to its proper place.

5. Put no solids into the sink. Unless your teacher tells you otherwise, only rinse liquids down the sink. Paper towels go into the trash (not into the recycling bin) when you are finished. Use the fewest paper towels that you can.

Data and Observations:

Station 1A

Reaction: _____Mg + _____O₂ → _____MgO

Observations:

Appearance of Reactants (BEFORE reaction occurs)–

________________________________________________________________________________________

________________________________________________________________________________________

What happened DURING the reaction? –

________________________________________________________________________________________

________________________________________________________________________________________

Appearance of Products (AFTER reaction occurred) –

________________________________________________________________________________________

________________________________________________________________________________________

Reaction Type:
Station 1B

Reaction: \( \underline{\text{_____Fe + _____O}_2} \rightarrow \underline{\text{_____Fe}_2\text{O}_3} \)

Observations:

Appearance of Reactants (BEFORE reaction occurs) –
________________________________________________________
________________________________________________________

What happened DURING the reaction? –
________________________________________________________
________________________________________________________

Appearance of Products (AFTER reaction occurred) –
________________________________________________________
________________________________________________________

Reaction Type:
_______________________________________________________

Station 2A

Reaction: \( \underline{\text{_____Pb(NO}_3\text{)}_2 + _____\text{NaCl}} \rightarrow \underline{\text{_____PbCl}_2 + _____\text{Na(NO}_3\text{)}} \)

Observations:

Appearance of Reactants (BEFORE reaction occurs) –
________________________________________________________
________________________________________________________

What happened DURING the reaction? –
________________________________________________________
________________________________________________________

Appearance of Products (AFTER reaction occured) –
________________________________________________________
________________________________________________________

Reaction Type:
_______________________________________________________
Station 2B

Reaction: \[ \underline{\text{_____Pb(NO}_3\text{)}_2 + \underline{\text{KI}} \rightarrow \underline{\text{PbI}_2 + \underline{\text{K(NO}_3\text{)}}} \]

Observations:
Appearance of Reactants (BEFORE reaction occurs)–
________________________________________________________________________________________
________________________________________________________________________________________

What happened DURING the reaction? –
________________________________________________________________________________________
________________________________________________________________________________________

Appearance of Products (AFTER reaction occurred) –
________________________________________________________________________________________
________________________________________________________________________________________

Reaction Type:

Station 3A

Reaction: \[ \underline{\text{____(NH}_4\text{)Cl + \underline{\text{Na}_2\text{(CO}_3\text{)}}}} \rightarrow \underline{\text{(NH}_4\text{)}_2\text{(CO}_3\text{)}} + \underline{\text{NaCl}} \]

Observations:
Appearance of Reactants (BEFORE reaction occurs)–
________________________________________________________________________________________
________________________________________________________________________________________

What happened DURING the reaction? –
________________________________________________________________________________________
________________________________________________________________________________________

Appearance of Products (AFTER reaction occurred) –
________________________________________________________________________________________
________________________________________________________________________________________

Reaction Type:
Station 3B

Reaction: \[ \text{CaCl}_2 + \text{Na}_2\text{(CO}_3\text{)} \rightarrow \text{Ca(CO}_3\text{)} + \text{NaCl} \]

Observations:

Appearance of Reactants (BEFORE reaction occurs):
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

What happened DURING the reaction? –
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Appearance of Products (AFTER reaction occurred):
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Reaction Type:
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Station 4

Reaction: \[ \text{Cu} + \text{Ag(NO}_3\text{)} \rightarrow \text{Ag} + \text{Cu(NO}_3\text{)}_2 \]

Observations:

Appearance of Reactants (BEFORE reaction occurs):
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

What happened DURING the reaction? –
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Appearance of Products (AFTER reaction occurred):
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Reaction Type:
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
Station 5

Reaction: \( \text{C}_6\text{H}_{14} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \)

Observations:
Appearance of Reactants (BEFORE reaction occurs) –
________________________________________________________________________________________
________________________________________________________________________________________
What happened DURING the reaction? –
________________________________________________________________________________________
________________________________________________________________________________________
Appearance of Products (AFTER reaction occurred) –
________________________________________________________________________________________
________________________________________________________________________________________

Reaction Type:
_______________________________________________________________________________________

Ideas to Discuss after doing the lab:

Chemical Change
________________________________________________________________________________________
________________________________________________________________________________________

Reaction
________________________________________________________________________________________
________________________________________________________________________________________

Endothermic Reaction
________________________________________________________________________________________
________________________________________________________________________________________

Exothermic Reaction
________________________________________________________________________________________
Types of Reactions

**Combination:**
Two atoms (or polyatomic ions) come together to form a compound.

Examples: \(2H_2 + O_2 \rightarrow 2H_2O\)

**Decomposition:**
A compound or polyatomic ion is broken down into its individual elements.

Examples: \(CO_2 \rightarrow C + O_2\)

**Single Replacement:**
An atom replaces the cation (+ part) of a compound to form a new compound and an element.

Examples: \(Zn + 2HCl \rightarrow ZnCl_2 + H_2\)

**Double Replacement:**
This reaction starts with two compounds as reactants and yields two new compounds as products. Each of the cations changes places and recombines with the anion of the other compound.

Examples: \(AlCl_3 + 3Li(OH) \rightarrow Al(OH)_3 + 3LiCl\)

**Combustion of a Hydrocarbon:**
A hydrocarbon is a compound made of only carbon and hydrogen atoms. When a hydrocarbon is burnt, it combines with oxygen from the air and always forms water and carbon dioxide as products.

Examples: \(CH_4 + O_2 \rightarrow CO_2 + H_2O\)
IPS—Balancing Equations/Reaction Types Practice

**Balance** the following equations and **identify each type** of chemical reaction you may use the following abbreviations C = combination, D = decomposition, SR = single replacement, DR = double replacement, COH = combustion of a hydrocarbon.

Type of Reaction

1. \( \text{Al} + \text{S} \rightarrow \text{Al}_2\text{S}_3 \)
2. \( \text{Au}_2\text{O}_3 \rightarrow \text{Au} + \text{O}_2 \)
3. \( \text{H}_2 + \text{N}_2 \rightarrow \text{NH}_3 \)
4. \( \text{NaF} \rightarrow \text{Na} + \text{F}_2 \)
5. \( \text{C}_3\text{H}_{12} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \)
6. \( \text{Ca}_3\text{N}_2 \rightarrow \text{Ca} + \text{N}_2 \)
7. \( \text{Zn} + \text{HNO}_3 \rightarrow \text{H}_2 + \text{Zn(NO}_3)_2 \)
8. \( \text{LiOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Li}_2\text{SO}_4 + \text{H}_2\text{O} \)
9. \( \text{Cl}_2 + \text{NaI} \rightarrow \text{NaCl} + \text{I}_2 \)
10. \( \text{Al} + \text{N}_2 \rightarrow \text{AlN} \)
11. \( \text{K} + \text{H}_2\text{O} \rightarrow \text{KOH} + \text{H}_2 \)
12. \( \text{AgNO}_3 + \text{AlCl}_3 \rightarrow \text{AgCl} + \text{Al(NO}_3)_3 \)
13. \( \text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \)
14. \( \text{Fe}_2(\text{CO}_3)_3 \rightarrow \text{Fe}_3\text{O}_5 + \text{CO}_2 \)
15. \( \text{Cr} + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2 + \text{Cr}_2(\text{SO}_4)_3 \)

**Tough Ones:** If you want a challenge, try these four. *Don’t spend more than 10 minutes on any one.* These are hard!!

16. \( \text{MnO}_2 + \text{HI} \rightarrow \text{MnI}_2 + \text{I}_2 + \text{H}_2\text{O} \)
17. \( \text{H}_3\text{AsO}_4 + \text{HCl} \rightarrow \text{Cl}_2 + \text{H}_2\text{O} + \text{As}_4\text{O}_6 \)
18. \( \text{H}_3\text{PO}_4 + \text{HCl} \rightarrow \text{P}_4 + \text{HOCl} + \text{H}_2\text{O} \)
19. \( \text{NaI} + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{S} + \text{H}_2\text{O} + \text{I}_2 + \text{Na}_2\text{SO}_4 \)
IPS—Reaction Rates Alka-Seltzer Lab

Purpose: To test what variables affect the rate of gas produced in the Alka-Seltzer experiment.

Materials: one gas collection apparatus, one or two Alka-Seltzer tablets, two 100 ml graduated cylinders, one water collection bin, one stopwatch, mortar and pestle (for crushed tablet)

Variables Tested:
1 = whole tablet / tap water  
2 = whole tablet crushed / tap water  
3 = whole tablet / tap water  
4 = half tablet / tap water  
5 = whole tablet / tap water  
6 = whole tablet / hot water

Paired Groups: Group 1 paired with group 2, 3 with 4, and 5 with 6

Drawing of Apparatus:

Procedure:
Each person in your group must pick a role from the list below:
   a) Data recorder  
   b) Time keeper and reader  
   c) Person to hold stopper onto flask  
   d) Person to read amount of water and report to recorder

Your groups should follow these set-up and lab procedures:
1. Fill the large flask/jar completely with tap water so that water starts to come up the tube.  
2. When ready, fill the small flask with 40 ml of clean tap water—the temperature that was assigned to your group.  
3. Add the tablet and quickly put the stopper in while holding the output tube over the graduated cylinder—start timing immediately.  
4. Read and record the amount of water that is pushed out every 10 seconds until the reaction stops.  
5. If your graduated cylinder gets almost to the top with water, get the 2nd one ready and pinch off the tube while you are switching—add the amount in the 2nd graduate to the amount in the 1st.  
6. When you’re done, empty out the Alka-Seltzer flask and rinse thoroughly. Repeat all the steps for trial #2.  
7. After trials one and two, find the AVERAGE for your results and record them in the data table.  
8. Find the group you’re partnered with and share your results with them—make sure to write theirs down on your data table.
## Group Data Table:  My Group # _____  Paired group # ____

<table>
<thead>
<tr>
<th>Time (seconds)</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>110</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Trial volume (ml)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2nd Trial volume (ml)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total of trial 1 and trial 2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>AVERAGE of trial 1 and trial 2 (÷ total by 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paired group average (ml)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Analysis of Data:

Make a graph showing the volume of gas produced (in ml) on the y-axis and the time (in seconds) on the x-axis for both your data and that of your paired group. Afterward, you should be ready to compare your results with the other group and present your overall results to the rest of the class using a whiteboard.
Questions

1. Define the term **VARIABLE**: 

2. Explain what the **variables** were in your particular Alka-Seltzer experiment and in the other group’s experiment.

3. Define the term **RATE OF REACTION**: 

4. How does the **rate of the reaction** of your Alka-Seltzer compare with the data from the other group? (list any patterns you notice).

Patterns in Data:

5. What **explanation** might you have about these results? (think about what the particles are doing)
Application Questions:
Use your knowledge of Reaction Rates and Types to answer the following questions

4. On the following graph, label the lines with the following labels and explain why you labeled the lines like you did.

Based on what you learned in the reaction rates lab and what you know about particles answer the following questions:

5. Why do some reactions require heat for them to occur?

6. What do you think would happen in the Alka-Seltzer lab if you used ice water? Talk about what the particles are doing when you explain your answer.

7. How do you know when a chemical reaction has happened?
IPS Balancing and Types of Reactions Practice

For numbers 1-5, balance the chemical equations and identify the reaction type.

1. ___ Na + ___ Cl  \rightarrow ___ NaCl
   Type____________________________

2. ___ C_2H_6 + ___ O_2  \rightarrow ___ CO_2 + ___ H_2O
   Type____________________________

3. ___ Ca(CO_3) + ___ Al  \rightarrow ___ Al_2(CO_3)_3 + ___ Ca
   Type____________________________

4. ___ HCl + ___ Na(OH)  \rightarrow ___ NaCl + ___ H_2O
   Type____________________________

5. ___ Na_2(CO_3)  \rightarrow ___ C + ___ Na + ___ O_2
   Type____________________________

6. Explain how you identify each of the following types of reactions when you see them:
   a. Combination

   b. Decomposition

   c. Single Replacement

   d. Double Replacement

   e. Combustion of a Hydrocarbon


Unit Review

1. Write the appropriate name of the following compounds below in the second blank, write the rule you used to determine the name.

   a. H(OH) ________________

   b. (NH₄)(NO₃) ________________

   c. Ca(CO₃) ________________

   d. Cr I₃ ________________

   e. Be₃(PO₄)₂ ________________

   f. Fe(SO₃) ________________

   g. Fe₂(SO₃)₃ ________________

   h. CBr₄ ________________

   i. Ag₂(SO₃) ________________

   j. NO₃ ________________

2. Write the correct formulas for the following compounds:

   a. Silver nitrate _____________

   b. Iron III oxide _____________

   c. Calcium peroxide _____________

   d. Chromium II sulfide _____________

   e. Chromium III sulfide _____________

   f. Arsenic pentafluoride _____________

   g. Sulfur trioxide _____________

   h. Strontium phosphate _____________

   i. Lithium peroxide _____________
j. Aluminum sulfate

3. The “3” in the compound, \( \text{Na}_3(\text{PO}_4) \), is called_____________

4. The “4” in 4 \( \text{NaCl} \) is called_____________

5. For the following, indicate the number of each of the following elements in each case. Beware of any coefficients!

   a. \( _2\text{C}_6\text{H}_{12}\text{O}_6 \quad \underline{\text{C}} \quad \underline{\text{H}} \quad \underline{\text{O}} \)
   b. \( _5\text{Br}_2 \quad \underline{\text{Br}} \)
   c. \( _4\text{P}_2\text{O}_5 \quad \underline{\text{P}} \quad \underline{\text{O}} \)
   d. \( _1\text{H}_3(\text{PO}_4) \quad \underline{\text{H}} \quad \underline{\text{P}} \quad \underline{\text{O}} \)
   e. \( _5\text{Co(NO}_2)_2 \quad \underline{\text{Co}} \quad \underline{\text{N}} \quad \underline{\text{O}} \)
   f. \( _1(\text{NH}_4)_2(\text{CO}_3) \quad \underline{\text{N}} \quad \underline{\text{H}} \quad \underline{\text{C}} \quad \underline{\text{O}} \)
   g. \( _4\text{Sr(OH)}_2 \quad \underline{\text{Sr}} \quad \underline{\text{O}} \quad \underline{\text{H}} \)
   h. \( _3(\text{NH}_4)_2(\text{NS})_3 \quad \underline{\text{N}} \quad \underline{\text{H}} \quad \underline{\text{S}} \)

6. Explain how you would recognize the following types of reactions:

   a. Single replacement:

_______________________________________________________________________
_______________________________________________________________________

   b. Decomposition

_______________________________________________________________________
_______________________________________________________________________

   c. Combustion of a hydrocarbon

_______________________________________________________________________
_______________________________________________________________________
d. Double replacement

_______________________________________________________________________

_______________________________________________________________________

e. Combination

_______________________________________________________________________

_______________________________________________________________________

7. Using circles with labels, draw diagrams in the empty boxes showing the reactants and the
number of products for the following equations.

a. \( \_\_\text{Cl}_2 + \_\_\text{H}_2 \longrightarrow \_\_\text{HCl} \)

b. \( \_\_\text{Mg(OH)}_2 + \_\_\text{H}_3\text{PO}_4 \longrightarrow \_\_\text{Mg}_3(\text{PO}_4)_2 + \_\_\text{H}_2\text{O} \)

8. For the following equations, if they are balanced correctly, write the word correct in the
blank. If they are not balanced correctly, write in the coefficient(s) that would make it
correct.

a. \( \_1\text{C}_3\text{H}_6 + \_5\text{O}_2 \longrightarrow \_3\text{CO}_2 + \_8\text{H}_2\text{O} \)

b. \( \_2\text{Na}_2\text{CO}_3 \longrightarrow \_2\text{C} + \_4\text{Na} + \_3\text{O}_2 \)

c. \( \_3\text{CaCl}_2 + \_2\text{Cu}_3\text{N} \longrightarrow \_6\text{CuCl} + \_3\text{Ca}_3\text{N}_2 \)

d. \( \_2\text{H}_3\text{PO}_4 + \_3\text{Ca(OH)}_2 \longrightarrow \_6\text{H}_2\text{O} + \_1\text{Ca}_3(\text{PO}_4)_2 \)

9. Balance the following equations and identify the type of reaction.
a. \( \text{C}_7\text{H}_{16} + \underline{\text{O}_2} \rightarrow \underline{\text{CO}_2} + \underline{\text{H}_2\text{O}} \)

b. \( \text{Ba(NO}_3\text{)}_2 + \underline{\text{Na}} \rightarrow \underline{\text{NaNO}_3} + \underline{\text{Ba}} \)

c. \( \text{CaBr}_2 + \underline{\text{Al}_2\text{O}_3} \rightarrow \underline{\text{CaO}} + \underline{\text{AlBr}_3} \)

d. \( \text{P}_4 + \underline{\text{O}_2} \rightarrow \underline{\text{P}_2\text{O}_5} \)

e. \( \text{C}_3\text{H}_7\text{OH} \rightarrow \underline{\text{C}} + \underline{\text{H}_2} + \underline{\text{O}_2} \)