For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.
Ionic and Covalent Bonds

Covalent Compounds

Covalent bonds are characterized by the sharing of electrons between two or more atoms. These bonds mostly occur between nonmetals or between two of the same (or similar) elements. Two atoms with similar electronegativity will not exchange an electron from their outermost shell; the atoms instead share electrons so that their valence electron shell is filled.

Examples of compounds that contain only covalent bonds are methane (CH$_4$), carbon monoxide (CO), and iodine monobromide (IBr).

Ionic Compounds

Ionic bonding occurs when there is a large difference in electronegativity (a measure of the tendency of an atom to attract a bonding pair of electrons) between two atoms. This large difference leads to the loss of an electron from the less electronegative atom and the gain of that electron by the more electronegative atom, resulting in two ions. These oppositely charged ions feel an attraction to each other, and this electrostatic attraction constitutes an ionic bond. Electronegativity generally increases moving from left to right across a period. The noble gases tend to be exceptions to this trend. Electronegativity generally decreases moving down a periodic table group. This correlates with the increased distance between the nucleus and the valence electron.

Ionic bonding occurs between a nonmetal, which acts as an electron acceptor, and a metal, which acts as an electron donor. Metals have few valence electrons, whereas nonmetals have closer to eight valence electrons; to easily satisfy the octet rule, the nonmetal will accept an electron donated by the metal. More than one electron can be donated and received in an ionic bond.

Some examples of compounds with ionic bonding include NaCl, KI, MgCl$_2$.

Properties of Covalent Compounds

- Gases, liquids, or solids (made of molecules)
- Atoms share electrons to become stable.
- Usually occurs between non-metals.
- Hydrogen and another non-metal chemically combines through covalent bonding.
- Low melting and boiling points.
- Poor electrical conductors in all phases.
- Many soluble in non-polar liquids but not in water.

Properties of Ionic Compounds

- Crystalline solids (made of ions)
- Metal atoms give electrons while non-metal atoms get electrons to become stable.
- Usually occurs between metals and non-metals.
- High melting and boiling points.
- Conduct electricity when melted.
- Many soluble in water but not in non-polar liquid.
Day 1:

Questions

1. How do covalent compounds form?
2. How are covalent compounds different from ionic compounds?

Classify the following properties as either Ionic or Covalent Compounds. Write ionic or covalent in red on the space before each property.

___________ 1. Atoms share electrons to become stable.
___________ 2. High melting and boiling points
___________ 3. Conduct electricity when melted
___________ 4. Usually occurs between non-metals.
___________ 5. Poor electrical conductors in all phases
___________ 6. Many soluble in non-polar liquids but not in water
___________ 7. Crystalline solids (made of ions)
___________ 8. Metal atoms give electrons while non-metal atoms get electrons to become stable.
___________ 9. Usually occurs between metals and non-metals.
___________ 10. Hydrogen and another non-metal chemically combines through covalent bonding.
___________ 11. Low melting and boiling points
___________ 12. Many soluble in water but not in non-polar liquid.
Classify the following as metal or non-metal and ionic or covalent compounds.

<table>
<thead>
<tr>
<th>Compound</th>
<th>First element/atom (metal or non-metal)</th>
<th>Second element/atom (metal or non-metal)</th>
<th>Ionic or Covalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₄</td>
<td>Carbon or C is a non-metal</td>
<td>Hydrogen or H in this case is exhibiting non-metallic properties.</td>
<td>Covalent</td>
</tr>
<tr>
<td>MgCl₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₂O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCl₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NaCl</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Day 2**

**Naming Covalent Compounds**

All names have two words.
- The first word is the same as the name of the first element in the formula.
- The second word is the same as the name of the second element with “ide” at the end.
- Use prefixes in front of each word to indicate how many of each atom are present in the compound.
- If mono is the first prefix, it is understood and is not written.
- Prefixes:

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>mono</td>
<td>2</td>
<td>di</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>tetra</td>
<td>5</td>
<td>penta</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>hexa</td>
<td>7</td>
<td>hepta</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>nona</td>
<td>10</td>
<td>deca</td>
<td></td>
</tr>
</tbody>
</table>

Examples:
- N₂O₄ is called dinitrogen tetraoxide
- CO₂ is called carbon dioxide
- CO is called carbon monoxide
- N₂O is called dinitrogen monoxide. (It is also called nitrous oxide but that is another naming scheme.)
- CCl₄ is called carbon tetrachloride
Name the following Compounds

1. N\textsubscript{2}O\textsubscript{5} __________________________________________________________
2. SeBr\textsubscript{6} ___________________________________________________________
3. CH\textsubscript{4} ____________________________________________________________
4. C\textsubscript{6}H\textsubscript{6} __________________________________________________
5. PF\textsubscript{6} ____________________________________________________________
6. BF\textsubscript{3} ____________________________________________________________
7. P\textsubscript{2}I\textsubscript{4} ___________________________________________________
8. S\textsubscript{2}Cl\textsubscript{3} _________________________________________________
9. NO\textsubscript{2} __________________________________________________________
10. P\textsubscript{2}O\textsubscript{5} ________________________________________________

Writing the chemical formula for Covalent Compounds

<table>
<thead>
<tr>
<th>Description of Action</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Look at the first word of the compound's name. Identify the element name. Write</td>
<td>N</td>
</tr>
<tr>
<td>the symbol for this element.</td>
<td></td>
</tr>
<tr>
<td>2. If the first name of the compound has a prefix, write the number the prefix</td>
<td>N\textsubscript{2}</td>
</tr>
<tr>
<td>refers to as the symbol’s subscript.</td>
<td></td>
</tr>
<tr>
<td>3. Look at the second word in the compound's name and identify the element. Only the</td>
<td>N\textsubscript{2}S</td>
</tr>
<tr>
<td>root of the element's name is used so the ending will be different. Write the symbol</td>
<td></td>
</tr>
<tr>
<td>for the element referred to.</td>
<td></td>
</tr>
<tr>
<td>4. Determine the number that the prefix of the second name refers to and write this</td>
<td>N\textsubscript{2}S\textsubscript{5}</td>
</tr>
<tr>
<td>number after the second symbol as a subscript.</td>
<td></td>
</tr>
</tbody>
</table>

Please write the formulas the formulas for the following compounds.

1. Dihydrogen monoxide ____________________________________________________________
2. Phosphorus trihydride ________________________________________________________
3. Dinitrogen trioxide __________________________________________________________
4. Carbon tetrachloride _________________________________________________________
5. Carbon dioxide _____________________________________________________________
6. Trinitrogen tetroxide ______________________________________________________
7. Dinitrogen monoxide _________________________________________________________
8. tetraphosphorus decaoxide _________________________________________________
Lewis Symbols

We use Lewis symbols to describe valence electron configurations of atoms and monatomic ions. A Lewis symbol consists of an elemental symbol surrounded by one dot for each of its valence electrons:

\[ \cdot \text{Ca} \cdot \]

For simple molecules, the most effective way to get the correct Lewis structure is to write the Lewis diagrams for all the atoms involved in the bonding and adding up the total number of valence electrons that are available for bonding. For example, oxygen has 6 electrons in the outer shell, which are the pattern of two lone pairs and two singles. If the electrons are not placed correctly, one could think that oxygen has three lone pairs (which would not leave any unshared electrons to form chemical bonds). After adding the four unshared electrons around element symbol, form electron pairs using the remaining two outer shell electrons.

\[ \begin{align*} &\vdots \quad \text{Incorrect structure} \\
&\ \vdots \\
&\cdot \text{O} \cdot \\
&\ \vdots \\
&\cdot \text{O} \cdot \\
&\ \vdots \\
\end{align*} \]

Correct structure

Examples

<table>
<thead>
<tr>
<th>Element</th>
<th>H</th>
<th>C</th>
<th>N</th>
<th>O</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>(\cdot)</td>
<td>(\cdot\text{C}\cdot)</td>
<td>(\cdot\text{N}\cdot)</td>
<td>(\cdot\text{O}\cdot)</td>
<td>(\cdot\text{F}\cdot)</td>
</tr>
</tbody>
</table>
Fill out the table with the appropriate Lewis symbols

<table>
<thead>
<tr>
<th>Atom</th>
<th>Number of Valence Electrons</th>
<th>Lewis Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silicon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfur</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argon</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>