Achieving Noble Gas Electron Configuration & Bonding

- In this powerpoint, electron shell filling will be reviewed.
- Recognize the appearance of Bohr’s Model after an atom lose or gains electrons, or how it bonds to hydrogen.
- Atoms lose electrons (OIL, oxidation) or gain electrons (RIG, reduction) to achieve noble gas electron configuration.

A. Valence electrons: Valence (outermost) electrons are in the principle energy shell furthest from the nucleus (the highest energy shell).
   a. Draw Bohr electron dot structures for the elements of period (row) 2.

   b. Draw Lewis electron dot structures on the elements of period (row) 2.

Group 1  Group 2  Group 3  Group 4  Group 5  Group 6  Group 7  Group 8

the group number equals the number of valence electrons for representative elements
Formation of Ions from Elements

Cation, $X^+$, Formation Oxidation (OIL) oxidation is loss of electrons

Anion, $X^-$, Formation Reduction (RIG) reduction is gain of electrons

This is a html hyperlink to a web QuickTime movie tutorial. If QuickTime movie player is not installed on your computer the link will not work.

http://www.sdmesa.sdccd.net/~dgergens/chem100/lewis_dot/_atomic_e_dot.html

Learn the names for these monatomic ions

<table>
<thead>
<tr>
<th>lithium</th>
<th>beryllium</th>
<th>boron</th>
<th>carbide</th>
<th>nitride</th>
<th>oxide</th>
<th>fluoride</th>
<th>neon</th>
</tr>
</thead>
<tbody>
<tr>
<td>ion</td>
<td>ion</td>
<td>ion</td>
<td>ion</td>
<td>ion</td>
<td>ion</td>
<td>ion</td>
<td>gas</td>
</tr>
</tbody>
</table>

These ions are isoelectronic with helium

These ions are isoelectronic with neon
Achieving Noble Gas
Electron Configuration

- Atoms lose electrons (OIL, oxidation) or gain electrons (RIG, reduction) to achieve noble gas electron configuration
- Recognize the appearance of Bohr’s Model after an atom loses or gains electrons to form ions, or how it shares electron when it covalently bonds to hydrogen.

Draw the following into your notes opposite page 64

**nonmetals** gain electrons to achieve noble gas e- configuration of the noble gas in their period (row)

\[
\begin{align*}
\text{C}^4- & \quad \text{N}^3- & \quad \text{O}^2- & \quad \text{F}^- \\
\text{carbide ion} & \quad \text{nitride ion} & \quad \text{oxide ion} & \quad \text{fluoride ion}
\end{align*}
\]

**nonmetals ions**
Ions isoelectronic ("same electronic configuration") with noble gases

Like charges repel electrostatic repulsions

Electrostatic attractions opposites attract

Ionic Bonding
Opposites attract
Ions brought together by electrostatics
Ions coming together to balance charge
**nonmetals** bond to hydrogen to achieve noble gas e- configuration of the noble gas in their period (row)

Addition of hydrogen

Achieving an OCTET valence

CH₄
methane gas

NH₃
ammonia gas

H₂O
water

HF
hydrogen fluoride

molecules of nonmetals hydrides

Achieving an OCTET valence (eight electrons in the outer most atom shell)

molecules of nonmetals hydrides

Circle nonbonding pairs of electrons
Ionic compounds are held together by strong electrical forces between oppositely charged ions (e.g., \(\text{Na}^+\), \(\text{Cl}^-\)). These forces are referred to as ionic bonds. Typically, ionic compounds (ionic salts) have relatively high melting points (e.g., \(\text{NaCl} = 801\, ^\circ\text{C}\)) and exist physically as solids at room temperature. It takes a lot of energy to break an ionic bond. Can you give additional examples of ionic compounds?

Molecular compounds. Two or more atoms may combine with one another to form an uncharged molecule. The atoms involved are usually those of nonmetallic elements. Within the molecule, atoms are held to one another by strong forces called covalent bonds.

diatomic molecules - there are seven diatomic molecules that behave as discrete units. The physical states for these molecules at room temperature are variable.

molecules with multiple bonding patterns

molecules of nonmetals hydrides

<table>
<thead>
<tr>
<th>Element</th>
<th>Bonding Pattern</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{H})</td>
<td>(\text{H-H})</td>
<td>gas</td>
</tr>
<tr>
<td>(\text{H})</td>
<td>(\text{H-H})</td>
<td>liquid</td>
</tr>
<tr>
<td>(\text{H})</td>
<td>(\text{H-H})</td>
<td>solid</td>
</tr>
</tbody>
</table>

**Summary**

- What is the favorite charge of these elements as ions? Indicate charge. Is there a relationship between the type of element that likes to have a positive charge? a negative charge?

  - Li: 1+  Be: 2+ C: 3+  N: 3-  O: 2-  F: 1-

- How many atoms will each element bond to in order to be stable? Indicate the number of bonds that each element will make.

  - Li: 1  Be: 2  B: 3  C: 4  N: 3  O: 2  F: 1

  - Is there a relationship between ion charge and the number of bonds an element will make? If so, describe the relationship.

<table>
<thead>
<tr>
<th>Element</th>
<th>Bonding Pattern</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{H})</td>
<td>(\text{H-H})</td>
<td>gas</td>
</tr>
<tr>
<td>(\text{N})</td>
<td>(\text{N=N})</td>
<td>gas</td>
</tr>
<tr>
<td>(\text{O})</td>
<td>(\text{O=O})</td>
<td>gas</td>
</tr>
<tr>
<td>(\text{Cl})</td>
<td>(\text{Cl-Cl})</td>
<td>gas</td>
</tr>
<tr>
<td>(\text{Br})</td>
<td>(\text{Br-Br})</td>
<td>liquid</td>
</tr>
<tr>
<td>(\text{I})</td>
<td>(\text{I-I})</td>
<td>solid</td>
</tr>
</tbody>
</table>

To these molecules, add missing nonbonding electron pairs.
Favorite covalent bonding modes for nonmetals \( C, N, O, \) halogen, \( H \)

- **Know** the preferred total number of covalent bonds to these elements
  - \( C, N, O, F, H \)
  - \( 4, 3, 2, 1, 1 \)

  - \( C, H \), nitrogen and oxygen may vary their total number of covalent bonds
    - \( 2 \) \( 1 \) \( 4 \) \( 3 \)

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**Ideal Geometries**

<table>
<thead>
<tr>
<th>bond angles</th>
<th>geometric name</th>
<th>valence shell electron pair repulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>109.5 ( \text{H-H} )</td>
<td>tetrahedral</td>
<td>( 4 ) ( 1 ) ( 3 ) ( 2 )</td>
</tr>
<tr>
<td>109.5 ( \text{H-H} )</td>
<td>trigonal planar</td>
<td>( 4 ) ( 1 ) ( 3 ) ( 2 )</td>
</tr>
<tr>
<td>120 ( \text{H-C-H} )</td>
<td>linear</td>
<td>( 4 ) ( 1 ) ( 3 ) ( 2 )</td>
</tr>
<tr>
<td>120 ( \text{H-C-H} )</td>
<td>linear</td>
<td>( 4 ) ( 1 ) ( 3 ) ( 2 )</td>
</tr>
<tr>
<td>180 ( \text{C=C} )</td>
<td>linear</td>
<td>( 4 ) ( 1 ) ( 3 ) ( 2 )</td>
</tr>
<tr>
<td>180 ( \text{C=C} )</td>
<td>linear</td>
<td>( 4 ) ( 1 ) ( 3 ) ( 2 )</td>
</tr>
</tbody>
</table>

**Non-Ideal Geometries**

- Bond angles for these non-ideal geometries are slightly smaller than an ideal angles because a nonbonded electron pair
  1) occupies a lot of space and
  2) is held close to nucleus of the central atom
Structure and Bonding

Go to the powerpoint
Rules for Drawing Lewis Dot Structures

Electron Orbital Filling revisited

F⁻ and Na⁺ are isoelectronic (the same electronically) with Ne

All elements lose or gain electrons to achieve noble gas e- configuration