Lesson 8: Electron Configuration

If we are interested in showing the arrangement of electrons in an atom in their orbitals, we can do this with electron configuration and orbital diagrams.

Electron configuration

List each type of orbital showing number of electrons as an exponent:

```
    orbital type  # of electrons
    3p^4
```

Orbital Diagrams

Boxes represent orbitals; tiny arrows represent electrons

<table>
<thead>
<tr>
<th>Orbital Diagram</th>
<th>Electron Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 1s ↑</td>
<td>1s^1</td>
</tr>
<tr>
<td>Hydrogen has 1 electron. It will be in the 1s orbital because it is the most favorable position (greatest attraction to nucleus).</td>
<td></td>
</tr>
<tr>
<td>He 1s ↑↑</td>
<td>1s^2</td>
</tr>
<tr>
<td>Helium has 2 electrons.</td>
<td></td>
</tr>
</tbody>
</table>

Follow the periodic table left to right, top to bottom to see the order in which electrons fill orbitals.
Goals:
- Derive electron configurations (short- and long-hand) and draw electron box diagrams of neutral atoms 1-20 and their ions based on their position on periodic table.
- Identify the name, symbol, valence electrons of the element or ion based on the electron configuration or box diagram.
- Determine # of core and valence electrons.
- Determine # of paired and unpaired electrons.

PRACTICE: Given the following atoms/ions, use the periodic table to...

a) Draw box diagrams for each element
b) Write the longhand electron configuration for each
c) State how many total & unpaired electrons are present
d) Circle the valence electrons.

1. Li
   - Total electrons: 3
   - Unpaired electrons: 1
   - Longhand electron configuration: $\begin{array}{c} 1s^2 2s^1 \end{array}$

2. Be
   - Total electrons: 4
   - Unpaired electrons: 0
   - Longhand electron configuration: $\begin{array}{c} 1s^2 2s^2 \end{array}$
3. B  
Total electrons: 5  Unpaired electrons: 1

Longhand electron configuration: 1s² 2s² 2p¹

4. C  
Total electrons: 6  Unpaired electrons: 2

Longhand electron configuration: 1s² 2s² 2p²

5. N  
Total electrons: 7  Unpaired electrons: 3

Longhand electron configuration: 1s² 2s² 2p³
6. O

Total electrons: 8  Unpaired electrons: 2

Longhand electron configuration: \(1s^2 2s^2 2p^4\)

7. F

Total electrons: 9  Unpaired electrons: 1

Longhand electron configuration: \(1s^2 2s^2 2p^5\)

8. Ne

Total electrons: 10  Unpaired electrons: 0

Longhand electron configuration: \(1s^2 2s^2 2p^6\)
9. K

Total electrons: 19
Unpaired electrons: 1

Longhand electron configuration: \( 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 \)

10. Ca

Total electrons: 20
Unpaired electrons: 0

Longhand electron configuration: \( 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 \)

**Rules and Principles for Electron Configuration:**

**Aufbau Principle:** an electron occupies orbitals in order from lowest energy to highest; from German for "building up"

an electron will occupy the 4s orbital before the 3d orbitals
Pauli Exclusion Principle: an orbital can contain only 2 electrons and they must have opposite spins.

Hund's Rule: every orbital in a subshell is singly occupied with one electron before any one orbital is doubly occupied; all electrons in singly occupied orbitals have the same spin.

IONS: Predict ion formed by Group A element by \_\_\_\_\_\_\_\_\_\_\_\_.

Group B elements are the \_\_\_\_\_\_\_\_\_\_\_\_.

1. \(\text{Al}^{3+}\)

Total electrons: 10 Unpaired electrons: 0

Longhand electron configuration: \([\text{Ne}]\) or \(1s^2 2s^2 2p^6\)

(Shorthand)
2. $S^{2-}$

Total electrons: 18  Unpaired electrons: 0

1s $\uparrow$  2s $\uparrow$  3s $\uparrow$

2p $\uparrow\uparrow\uparrow\uparrow\uparrow$

3p $\uparrow\uparrow\uparrow\uparrow\uparrow$

3d

Longhand electron configuration: $1s^2\ 2s^2\ 3s^2\ 2p^6\ 3s^2\ 3p^6$

3. $Cl^-$

Total electrons: 18  Unpaired electrons: 0

1s $\uparrow$

2s $\uparrow$

3s $\uparrow$

2p $\uparrow\uparrow\uparrow\uparrow\uparrow$

3p $\uparrow\uparrow\uparrow\uparrow\uparrow$

3d

Longhand electron configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

4. $Ca^{2+}$

Total electrons: 18  Unpaired electrons: 0

1s $\uparrow$

2s $\uparrow$

3s $\uparrow$

2p $\uparrow\uparrow\uparrow\uparrow\uparrow$

3p $\uparrow\uparrow\uparrow\uparrow\uparrow$

3d

Longhand electron configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
Shorthand Electron Configuration:

- Saves you time in writing electron configurations for heavier elements.
- Makes use of the fact that Noble gases have complete/full outer shells (short hand is also known as “Noble gas notation”)
- **Steps**: Write the chemical symbol for the noble gas in front of the configuration in square brackets. Write the configuration for any additional electrons in the standard format.

**Calcium**:  \([\text{Ar}] 4s^2\)

*Calcium has “the configuration of Argon plus 2 4s electrons”*

Write the shorthand electron configuration for these neutral atoms. Then, write the number of total electrons.

1. Li ___________________________  Total e's: ______
2. O ___________________________  Total e's: ______
3. K ___________________________  Total e's: ______

Write the shorthand electron configuration for the ions of these elements. Then, write the number of total electrons.

1. Be \(\rightarrow\) ______  ___________________________  Total e's: ______
2. F \(\rightarrow\) ______  ___________________________  Total e's: ______
3. Al \(\rightarrow\) ______  ___________________________  Total e's: ______
4. Cl \(\rightarrow\) ______  ___________________________  Total e's: ______