Lesson 7: Modern Atomic Theory & Intro to Electron Configuration

Background & Early Models
At high temperatures, or when subjected with high voltages, elements in the gaseous state give off
___________________________________________ (example: neon signs). If you pass the emitted light through a
prism, you see a set of brightly colored lines called a ____________________________. The colored lines indicate
that the light is being emitted only at certain wavelengths, or frequencies, that correspond to different colors.
Each element has _______________________________ that is different from the sets of
the other elements.

Emission Line Spectra:

- Hydrogen
- Helium
- Neon

The color (wavelength $\lambda$) of the light is determined by the difference in energy between the two states
(ground vs. excited state).
Niels Bohr studied the line spectrum of ___________________ (1912-1913). He concluded that

Bohr visualized electrons ___________________ around the nucleus like planets around the sun.

Bohr published data on the hydrogen atom (one electron revolving in orbit around a dense nucleus). Bohr theorize that electrons have ___________________ corresponding to the different possible orbits around the nucleus; an electron has to be in one specific energy level and never __________ energy levels. If a hydrogen atom absorbed one or more ___________________ (packet) of energy, its electron “jumped” to a ___________________. The lowest energy level for an electron is called the ________________. When an electron falls from a higher energy state to a lower energy state, it ___________________________ at a specific frequency. Each line visible in the hydrogen line spectrum corresponds to an electron falling from a higher energy state to a lower energy state. Bohr contributed a lot to our knowledge of atomic substructure, but his model and calculations did not work for ___________________.

**Bohr Model**

The ______________________________ of an element and ______________________________ depend on the ______________________________ within the atoms.
Louis de Broglie (1924) suggested that all objects have __________________________, but the wave properties for larger objects (like marbles or pencils) are __________________________.

Electrons behave like ______________ confined to the space around the atomic nucleus. Light behaves like a stream of tiny packets of energy called __________________. __________________ and electrons have __________________________, behaving like __________________________.

Erwin Schrödinger (1926) created a __________________________.

With this model, we can determine the probability of finding an electron in a certain region within the electron cloud.

We now know what electrons are not revolving around the nucleus; they exist in __________________. An orbital is a three-dimensional region in space around the nucleus where there is a __________________________ of finding a given electron.

**Electron Orbitals:**

The intensity of the dots shows where the electron is likely to spend more time around the nucleus.

The __________________________ of an electron cannot be measured __________________________. This is called the __________________________.

The uncertainty principle contradicts Bohr’s idea of electrons existing in specific orbits with a known velocity and radius. In order to “see” electrons, they must be bombarded with __________________________.

Photons and electrons have the same amount of __________________________, so photons will __________________________.
Location and Types of Electrons in the Electron Cloud

- **Valence electrons** are located _____________________________ and are the highest-energy electrons. The number of valence electrons in a neutral element is equal to _____________________________. These electrons are involved in chemical bonding.

- **Core electrons** are all the electrons that are ___________________________. The closer electrons are to the nucleus, the ___________________________.

<table>
<thead>
<tr>
<th>Element</th>
<th># of Protons</th>
<th>Total electrons</th>
<th>Valence electrons</th>
<th>Core electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cl</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si⁺⁺⁺</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F⁻</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mg²⁺</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S²⁻</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This is a(n) neutral atom / ion of ___________________________. It has _____ total electrons, ______ valence electrons and _____ core electrons.

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Energy Levels of Electrons.

1. Principle energy level
   a. Designated with the letter ____
   b. Lowest principle energy level is __________
   c. As \( n \) increases, the energy of the electron ________________ and the electron is found on average ________________ from the nucleus
   d. Corresponds to ____________________________ on the Periodic Table

2. Sublevels
   a. Designated with letters ___________________ and each has a distinct shape
   b. Each sublevel contains spaces for electrons called orbitals
   c. Corresponds to ___________________________ on the Periodic Table

3. Orbitals
   a. Designated with letters ___________________ and each has a distinct shape
   b. Each can hold _______ electrons, each with an ____________________________

Types of Sublevels and Orbitals:

- **s orbital**
- **p orbitals**
- **d orbitals**
- **f orbitals**
<table>
<thead>
<tr>
<th>Orbital Type</th>
<th>Shape</th>
<th># of configurations</th>
<th># of orbitals per sublevel</th>
<th>maximum # of total electrons sublevel can hold</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td>Spherical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>Dumbbell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Clover leaf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

References:
https://chem.libretexts.org/Textbook_Maps/Introductory_Chemistry/Book%3A_Introductory_Chemistry_(CK-12)/05%3A_Electrons_in_Atoms/5.11%3A_Quantum_Mechanical_Atomic_Model
Choose a color to label each sublevel block. Then, color in the Periodic Table. You’ll use this to determine the electron configuration of elements based on their location on the Table.