Name:

Unit 3 Guide-Electrons In Atoms

Importance of Electrons
- Draw a complete Bohr model of the atom.
- Write an element’s electron configuration. Know how the symbols used in ECs relate to electron properties and location.
- Complete orbital diagrams and know what they represent in an atom.
- Determine number of valence electrons in an atom and explain why they are important.
- Determine the energy level that the electrons are in and relate these properties to the periodic trends observed.
- Draw electron dot diagram. Know what information is included in these and why certain information can be left out.

Role of Light in the Discovery of Atomic Models
- Show how light is absorbed and released using Bohr models.
- Explain why atoms emit a unique spectral pattern.
- Predict which transitions will result in higher energy light.
- Describe the relative energies of parts of the electromagnetic spectrum

Periodic Trends
- Understand inner-shell shielding
- Understand effective nuclear charge
- Atomic size
  - Describe the trend across a period and down a group
  - Explain the behavior of the trend
- Chemical Reactivity of the Alkali and Alkaline Earth Metals
  - Describe the trend across a period and down a group

Keywords:
- Bohr Model
- Orbitals
- Energy Level
- Valence electron
- Core electron
- Electron Dot Diagram
- Atomic radius
- Ground state
- Excited state
- Visible light
- Bright Line Spectrum
- Ion
- Cation
- Anion
- Ionization Energy
- Electronegativity
- Electron Configuration
- Orbital Boxes
- Noble gas notation
- Period
### Electron Structure Unit

<table>
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<th>Topic</th>
</tr>
</thead>
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<td>9/29</td>
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<td>Orbital Boxes Notes and Practice</td>
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<td>10/12</td>
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<td>10/20</td>
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</tr>
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<td>10/21</td>
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**9/29/16**  
**Objective:** Students will be able to draw a Bohr Model of an atom and identify the number of protons, neutrons, and valence/core electrons.

**Warm-up:**
1. What are two things that I want you to know by the end of this unit?
2. When is your unit exam?

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**Bohr Model to Represent Electrons**

**Electron Review**
- Electrons orbit the nucleus in the space called the “______________”.
- They have a ________ charge
- Atomic mass = 1/1836 (so tiny, we don’t even count it!)
- Electrons are located in ______________________ around the nucleus.
  - This is just how far away from the nucleus an electron is
The Bohr Model of the Atom

- Niels Bohr’s model of the atom focused on the description of the electrons in an atom.
- Different atoms have different numbers of orbitals, which determines how many electrons each atom can have. Label the orbitals on the periodic table below.

![Periodic Table]

- Example: How many orbitals do the following atoms have?
  - Zr
  - C
  - Au
  - H
  - Pa

- Each orbital can hold a specific amount of electrons:
  - 1st energy level:
  - 2nd energy level:
  - 3rd energy level:
  - 4th energy level:
  - Number of electrons in the outermost energy level
  - All electrons minus the valence electrons

- The farther away the electrons are from the nucleus, the __________ an atom has.
- For example: elements with 5 orbitals have more energy than elements with 2 orbitals.
- Which energy level has the highest energy?
  - 1 or 5
  - 7 or 2
  - 3 or 4
Drawing a Bohr Model

- Rules for filling electron orbitals:
  - Always start at the level \textbf{near} the nucleus
  - Each level \textbf{must} be full before you can move to the next.

- How to draw Bohr Models:
  1. Determine the number of protons, neutrons and electrons that an atom has.
  2. Start at the level \textbf{closest} to the nucleus and add \textbf{all} electrons.
  3. If more than 2 electrons, move to the \textbf{next} energy level and continue to fill in electrons.
     a. Remember: this level gets \textbf{more}.
  4. Continue to fill in \textbf{all} until there are no more electrons.
  5. Look at the electrons in the outermost energy level, these are the \textbf{valence electrons}.
  6. The \textbf{core electrons} are all the electrons in the inside of the electron cloud.
  7. Double Check: does your number of orbitals drawn equal the number of orbitals that it should have from the periodic table?

Example: Draw the Bohr Model for the following atoms then fill in the subatomic particles.

<table>
<thead>
<tr>
<th>Bohr Model</th>
<th>N</th>
<th>Br</th>
<th>Xe</th>
</tr>
</thead>
<tbody>
<tr>
<td>#p+:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#n0:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># e-:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># valence electrons:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># core electrons:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy level of valence e-:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Objective: Students will be able to draw a Bohr Model of an atom and identify the number of protons, neutrons, and valence/core electrons.

Warm-up: How many orbitals do the following elements contain?
- Sr
- Cl
- Sn
- Hs

Trends of the Periodic Table

Atomic Radius
- The atomic radius of an element is defined as the distance between two bonded atoms of the element.
- As you move across the periodic table, the atomic radii of the elements .
  - This is because the nuclei of these elements pick up more protons, while the energies of the electrons stay the same. Since the nucleus can pull harder but the electrons have the same energy, the electrons get pulled closer to the nucleus.
- As you move a group, the atomic radius .
  - That’s because the electrons are in higher energy levels, which puts them in bigger orbitals.

Bright Line Spectrum
- Electrons can move between orbitals! Electrons in the outer orbitals have energy. Electrons in inner orbitals have energy.
- Atoms are stable when the electrons are in the orbitals with the lowest possible energies-called the .
- Atoms are excited when the electrons are in the orbitals with the higher energies-called the .
- When electrons move from an excited state to a ground state, they will release ! We can use these bands of light to determine what element is present.
- Draw the electromagnetic spectrum below.
  - : is also called white light
  - All the colors of the are present in white light.

- Bright Line Spectrum
  - When elements are exposed to electromagnetic waves, they will emit light in certain patterns, these are called .
  - Scientists have already tested all the elements on the periodic table, and each one had a unique spectral pattern.
Scientists can use these to identify what elements make up stars and planets in our universe.

 has the longest wavelength, and therefore the least amount of energy. On the other end, has the shortest wavelength and therefore the most amount of energy.

10/3/16
Objective: Students will be able to use a Bohr model and the periodic table to draw an Electron Dot Diagram.

Warm-Up: Draw a Bohr Model for the following atoms and fill in the subatomic particles.

<table>
<thead>
<tr>
<th></th>
<th>Rb</th>
<th>Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>#p+:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#n0:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#e-:</td>
<td></td>
<td></td>
</tr>
<tr>
<td># valence electrons:</td>
<td></td>
<td># valence electrons:</td>
</tr>
<tr>
<td># core electrons:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vocabulary Tic-Tac-Toe

- Define Orbital.
- Draw a picture of Electron Dot Diagram.
- Act Out Excited State.
- Use Visible Light in a Sentence.
- Pair Core Electron with another Vocabulary Word and explain why they go together.
- Explain how you are going to remember the definition for atomic radius.
- Draw a picture of valence electrons.
- Explain the pieces of the Bright Light Spectrum to your partner.
- Define Ground State.

**Electron Dot Diagrams:**

- Electron Dot Diagrams are a ________________ to show the ________________ in an atom.
- ________________ are the number of electrons on the outermost energy level of the atom.
- To draw Electron Dot Diagrams:
  1. Determine the number of valence electrons in the atom by drawing a ________________.
  2. Write the element symbol.
3. Draw dots around the diagram (like around the four sides of a box).
   a. Start on the ____________________.
   b. Draw ________________________________.
   c. Do one electron on each side before pairing the electrons.

Examples:

C               Ar

10/4/16
Objective: Students will be able to determine if an element forms a cation or anion and identify the subatomic particles for the ion.

Warm-Up:
1. How many valence electrons do the following elements contain?
   • Na
   • F
   • Ga
2. Draw an Electron Dot Diagram for those elements.

Ions

   • Ions are atoms that have ____________________ or ____________________ electrons to have an electrical charge.
   • The number of ______________________ does not change in an ion
   • The number of ______________________ does not change in an ion
   • So, both the ______________________ and the ______________________ remain the same.
   • To tell the difference between an atom and an ion, look to see if there is a charge in the superscript.
     o Examples: Na+ vs Na, Ca2+ vs Ca, I- vs I, O2- vs O

Forming Cations

   • A ____________________ forms when an atom ____________________ one or more electrons.
     Therefore, the charge of the atom will be ________________!
   • Draw an example of a cation below.

   • In general, ____________________ will lose electrons to form a cation.
Forming Anions

- An ________________ will form with an atom ________________ one or more electrons. Therefore, the charge will be ________________!
- Draw an example of an anion below.

- In general, ________________ will gain electrons to form anions.

To determine if it is a cation or anion:

- Look at the charge
  - ________________: lost electron
  - ________________: gained electrons
- Look at the number: this is how many were gained or lost

Example: for the following ions, determine if they are gaining or losing electrons, how many and if they form a cation or anion.

<table>
<thead>
<tr>
<th>Ion</th>
<th>Gaining/Losing</th>
<th>How Many</th>
<th>Cation or Anion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>2+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al</td>
<td>3+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>2-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Li</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Br</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example: State the number of protons, neutrons and electrons in each of these ions.

<table>
<thead>
<tr>
<th>Ion</th>
<th>$^{39}$K$^+$</th>
<th>$^{16}$O$^-$</th>
<th>$^{41}$Ca$^{2+}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>#p$^+$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#n$^0$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#e$^-$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example: Determine if the following elements are a cation or an anion. Then, write the nuclear symbol for each.

a. 8 protons, 8 neutrons, 6 electrons

b. 17 protons, 20 neutrons, 18 electrons

c. 47 protons, 60 neutrons, 45 electrons

Example: Draw a Bohr model for the following ions.

a. B^{3+}  \hspace{2cm} P^{3-}  \hspace{2cm} Na^{+}

Charges on Common Ions

- By losing or gaining electrons, an atom has the ________________ number of electrons as the nearest ________________ (Noble Gases) atom.
- An ion that an element will form can be predicted from the periodic table!
- Label the common charges on your periodic table!
Objective: Students will be able to determine if an element forms a cation or anion and identify the subatomic particles for the ion.

Warm-Up: Draw a Bohr Model for the following ions, then fill in the subatomic particles.

<table>
<thead>
<tr>
<th></th>
<th>Ca^{2+}</th>
<th>P^{3-}</th>
</tr>
</thead>
<tbody>
<tr>
<td>#p^+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#n0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#e^-</td>
<td></td>
<td></td>
</tr>
<tr>
<td># valence electrons</td>
<td></td>
<td></td>
</tr>
<tr>
<td># core electrons</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Trends of the Periodic Table

Octet Rule: atoms tend to lose or gain electrons so that they have the same number of electrons as the nearest __________________________ (8 valence electrons).
- The nearest noble gas may be before or after the element.
- If it is before the element, the atom will ____________ electrons.
- If it is after the element, the atom will ____________ electrons.
- We ignore the transition metals (the short columns).

Ionization Energy
- The ____________________________ of an element is the amount of energy it takes to pull one electron off of an atom.
- As you move _________________ to _________________ across the periodic table, the ionization energy ____________________________.
  - This is because elements on the left side of the periodic table want to lose electrons so it doesn’t take much energy to remove them.
  - Electrons on the right side of the periodic table want to gain electrons so it takes a lot of energy to remove one.
- As you move _________________ the periodic table, the ionization energies of the elements ____________________________.
  - This is due to ____________________________: the electrons in the orbitals near the nucleus shove electrons further from the nucleus away from them.
    - Remember, the like charges of the electrons means that they will repel each other!
  - Since the electrons in the ________________ orbitals are repelled, they require less energy to remove.
Electronegativity

- The __________________________ of an element measures how hard it tries to pull electrons away from other atoms it is bonded to.
  - Elements on the __________ side of the table have a __________ electronegativity because they want to grab electrons.
  - Elements on the __________ side of the table have a __________ electronegativity because they want to lose electrons.
  - Noble gases don’t want to gain electrons at all so they have no noticeable electronegativity at all.

10/6/16
Objective: Students will develop their ICAP using Naviance.

Warm-Up: None

10/7/16
Objective: Students will be able to use an orbital filing diagram to write an electron configuration and identify the type of orbital the valence electrons are in.

Warm-Up: Draw the atomic symbol for the following ions.
- 8 protons, 10 electrons, 8 neutrons
- 14 protons, 16 electrons, 14 neutrons
- 25 protons, 23 electrons, 30 neutrons

Vocabulary Dice
Roll two dice. The first dice tells you the vocabulary word. The second dice tells you the task. Switch back and forth with your partner until the teacher calls time.

Vocabulary Words
1. Ion
2. Cation
3. Anion
4. Ionization Energy
5. Electronegativity
6. Valence Electron

Activity
1. Give the definition in your own words.
2. Draw a picture of the word.
3. Pair the word with another vocabulary word and explain why you paired them together.
4. Give an example of the word.
5. Use the word in a sentence.
6. Explain how you are going to remember the word.
Electron Orbitals and Orbital Filling Diagram Notes

We can simplify the Bohr Model by simply drawing the energy levels. Label the energy levels on the following diagram.

Within each energy level, there are sub-levels called orbitals. Each different energy level has a different number of sub-levels. Label the sub-levels on the diagram below.

An orbital is a specific defined space that there is a high probability of finding the electron. Draw the shape of the s, p and d orbital below.
Orbital Filling Diagrams
1. Determine the _______ of _______ the atom has.
2. Start at the _______ energy level and fill up. (Aufbau principle)
3. Only _______ electrons per _______(Pauli exclusion principle)
4. For the p, d, and f orbitals, fill each degenerate level with _______ electron, then go back
   and add more. (Hund’s rule).
5. Once the diagram in filled, condense the diagram to write out the ________

Examples:
As:  

\[ \text{K:} \]
Use these tables to fill the orbitals of these elements.

<table>
<thead>
<tr>
<th>Element</th>
<th>Mg</th>
<th>Al</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1s</td>
<td></td>
<td></td>
<td>1s</td>
</tr>
<tr>
<td>2s</td>
<td></td>
<td>2s</td>
<td>2s</td>
</tr>
<tr>
<td>3s</td>
<td>3p</td>
<td>3p</td>
<td>3p</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Element</th>
<th>C</th>
<th>Cl</th>
<th>Ne</th>
</tr>
</thead>
<tbody>
<tr>
<td>1s</td>
<td></td>
<td></td>
<td>1s</td>
</tr>
<tr>
<td>2s</td>
<td></td>
<td>2s</td>
<td>2s</td>
</tr>
<tr>
<td>3s</td>
<td>3p</td>
<td>3p</td>
<td>3p</td>
</tr>
</tbody>
</table>
Electron Configurations

- Method of representing electron filling
- The “______” of the e’s in an atom
- Determined by filling order (Aufbau, Pauli exclusion, Hund’s rule)
- Label the following diagram.

2p^5

- Note:
  - ______________________ included with ______________________
  - Use ______________________ letters for orbital types (3p NOT 3P)
  - # of e’ in orbital = ______________________

10/10/16

Objective: Students will be able to use an orbital filling diagram to write an electron configuration and identify the subatomic particles from the electron configuration.

Warm-Up:
Use these tables to write the electron configuration for these elements. u

<table>
<thead>
<tr>
<th>Si</th>
<th>Ar</th>
<th>Na</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing Energy of Elec</td>
<td>Increasing Energy of Elec</td>
<td>Increasing Energy of Elec</td>
</tr>
<tr>
<td>1s —</td>
<td>1s —</td>
<td>1s —</td>
</tr>
<tr>
<td>2s —</td>
<td>2s —</td>
<td>2s —</td>
</tr>
<tr>
<td>3s —</td>
<td>3s —</td>
<td>3s —</td>
</tr>
<tr>
<td>3p —</td>
<td>3p —</td>
<td>3p —</td>
</tr>
<tr>
<td>3p —</td>
<td>3p —</td>
<td>3p —</td>
</tr>
</tbody>
</table>
Objective: Students will be able to fill orbital boxes from the electron filling diagram.

Warm-Up: Use these tables to fill in the orbitals of these elements and then write their electron configuration.

<table>
<thead>
<tr>
<th>Element</th>
<th>Co</th>
<th>Ga</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>3p—</td>
<td>3p—</td>
<td>3p—</td>
<td></td>
</tr>
<tr>
<td>2p—</td>
<td>2p—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1s—</td>
<td>1s—</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EC:

Orbital Box Diagrams

- An orbital box diagram is a __________________________ version of the _______________________.
- Example: Carbon (Z=6 therefore e- = 6)

- Note:
  - Each box = ________________________________
  - Arrows = _________________________________
- Each sub-level has a different number of boxes that represents the number of orbitals in each.
  - s:
  - p:
  - d:
  - f:

To write orbital boxes from the orbital filling diagram

1. Write the ___________________________ first.
2. Draw the ___________________________ for each orbital.
3. Place electrons in the boxes using ___________________. Since electrons spin in opposite directions, we use ___________. Remember, each orbital can hold only _______ electrons.
   a. Start with the 1s orbital
   b. Fill in all boxes with an ________ arrow before placing a ______________ arrow
4. Continue with each energy level and sub-level until all electrons are filled.
Example: Draw the orbital boxes for Sulfur.

Example: Draw the orbital boxes for Silicon.

10/12/16
Objective: Students will use the periodic table to write the electron configurations of atoms.

Warm-Up:
Draw the orbital boxes for the following electron configurations.
- \(1s^22s^22p^63s^23p^6\)
- \(1s^22s^22p^63s^23p^64s^23d^4\)

Electron Configuration from the Periodic Table
Use 4 different colors to represent the location of the s, p, d, and f blocks:

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</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>

| 55 | 56 | 57 |
| 58 | 104 |
| 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 |

Using the Periodic Table to Write Electron Configuration
1. Start at _________________________. This is \(1s^1\). Then go to Helium, this is \(1s^2\).
   a. Each box counts as the next _________________ in that sublevel.
2. Once you reach the end of the ______________________, write this down on your paper.
3. Continue to follow the periodic table, writing down the configuration as you go.
4. _______________ when you get to the element you are writing the electron configuration for.

Example: Write the electron configurations for the following elements:
- Si
- Ar
- Ca

Finding the valence electrons from the Electron Configuration
- The valence electrons are the electrons in the ___________________________________ energy level.
  1. Find the highest ___________________________ (the numbers)
  2. Count the ___________________________ in all sublevels (the letters) of this energy level.
  3. Example:

Example: How many valence electrons do the following elements have?
- $1s^22s^22p^63s^23p^64s^23d^9$
- $1s^22s^22p^2$
- $1s^22s^22p^63s^23p^64s^23d^44p^4$
- $1s^22s^22p^63s^23p^64s^23d^104p^65s^24d^4$

Example: How many core electrons do the following elements have?
- $1s^22s^22p^63s^23p^1$
- $1s^22s^22p^63s^23p^64s^23d^1$
- $1s^22s^22p^4$
- $1s^22s^22p^63s^23p^5$

Example: What type of orbital are the valence electrons in for the following elements:
- Na
- Cu
- O
- Ce
10/13/16
Objective: Students will use the periodic table to write the electron configurations of atoms.

Warm-Up:
Use the following electron configuration to answer the following questions:
1s²2s²2p⁶3s²3p⁶4s²3d¹⁰4p³
1. How many valence electrons are there?
2. How many core electrons are there?
3. What type of orbital are the valence electrons in?

10/14/16
Objective: Students will use Noble Gas Notation to write the electron configuration for elements.

Warm-Up:
1. What is the name of the elements that comprise the D Block?
2. What element does the following electron configurations correctly describe?
   a. 1s²2s²2p⁶3s¹
   b. 1s²2s²2p⁶3s²3p⁴
   c. 1s²2s²2p⁶3s²3p⁶4s²3d⁸

Noble Gas Notation

Example: Na (11 e⁻)

\[
\begin{align*}
1s^22s^22p^6 & \quad \underline{3s^1} \\
\end{align*}
\]

Noble Gas Notation is a way to write the electron configuration. Use the previous to represent the.
Example: [Ne] 3s¹

Steps for writing Noble Gas Electron Configuration
1. Determine the that is one row up from the element.
2. Put the for the Noble Gas in .
3. Continue writing the electron configuration using the periodic table the Noble Gas.
Examples:
- P (15 e-)
- Ca (20 e-)
- Br (35 e-)

10/17/16

**Objective:** Students will discover some common trends on the periodic table.

**Warm-Up:**

How many core electrons do the elements with the following configurations have?
- [Ne]3s²3p¹
- [Ar]4s²3d³
- [Kr]5s²

10/18/16

**Objective:** Students will demonstrate their knowledge of electron structures on a WebAssign.

**Warm-Up:** Vocab Bingo

Fill the following boxes with the vocabulary List on the front page of this packet.

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10/19/16

Objective: Students will demonstrate their knowledge of electron structure on a unit review.

Warm-Up:

1. Describe the trend of ionization energy across the periodic table.

2. Which of the following elements has the largest atomic size? (Circle one) Ba or Br

3. Which of the following elements is the most reactive? (Circle one) S or K

10/20/16-10/21/16

Objective: Students will demonstrate their knowledge of electron structure on a unit test.

Warm-Up: Turn in your homework.