GENERAL CHEMISTRY 1
Quarter 2 - Module 1
Quantum Numbers

Name of Learner: __________________________
Grade & Section: __________________________
Name of School: __________________________
What I Need to Know
In your grade 9, you have learned all about electrons and its behavior. You were able to learn on the quantum mechanical model which describes the atom as having a nucleus at the center around in which the electrons move. Also, you were able to write electronic configuration. With those background, it is now easy for you to understand this next topic. At the end of this module, you are expected to:
1. Use quantum numbers to describe an electron in an atom. (STEM_GC11ESIIa-b-54);
2. Determine the magnetic property of the atom based on its electronic configuration. (STEM_GC11ESIIa-b-57)
3. Draw an orbital diagram to represent the electronic configuration of atoms. (STEM_GC11ESIIa-b-58)

What’s In
Activity 1. Remember Me?
Directions: Matching type. Let’s see how far you can still remember the lesson learned in your Grade 9. For each item in Column B (the definition of certain principles), write the letter of the matching item in Column A (principles/concept of Quantum mechanical theory).

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>___1. Heisenberg Uncertainty Principle</td>
<td>A. The modern model of an atom which treats electrons as waves</td>
</tr>
<tr>
<td>___2. Schrodinger wave equation</td>
<td>B. States that it is impossible to know both the velocity and the position of the particle at the same time</td>
</tr>
<tr>
<td>___3. Quantum mechanical model</td>
<td>C. a three- dimensional region around the nucleus representing the probability of finding an electron</td>
</tr>
<tr>
<td></td>
<td>D. way in which electrons are distributed in the different orbitals around the nucleus of an atom.</td>
</tr>
</tbody>
</table>

Activity 1 helps you recall the development of atomic model. Also, It was said that it is not possible to measure the exact position and the exact momentum of a particle at the same time through the Uncertainty Principle and it was the Scrodinger Equation that provided the idea of the electron’s position.
Now, let’s move on to the next activity!

**What’s New**

**Activity 2. What Quantum Number am I?**

**Directions:** Read the text below and identify the following statement as *n* for Principal quantum number, *l* for Angular Momentum quantum number, *ml* for magnetic quantum number or *ms* for Electron Spin quantum number.

The four quantum numbers are the principal quantum number (*n*), the angular momentum quantum number (*l*), the magnetic quantum number (*ml*) and the spin quantum number (*ms*). The first three quantum numbers describe the energy, shape and orientation of orbitals while the spin quantum number refers to two different spin orientations of electrons in a specified orbital. These are "spin-up" or "spin-down" and is assigned the number +½ and -½, respectively.

—1. Describes the orientation of the orbital in space
—2. It is usually designated by letters s, p, d, f, ... which have a historical origin from spectral lines.
—3. Is related to the average distance of the electron from the nucleus in a particular orbital; the larger the *n* value, the farther the average distance of the electron from the nucleus
—4. It refers to two different spin orientations of electrons in a specified orbital.
—5. Determines the orbital size

**Activity 3. Know the QN better**

**Directions:** Study the table below then answer the questions that follow by ticking the box of the correct answer.

<table>
<thead>
<tr>
<th>Principal Quantum Number, <em>n</em></th>
<th>Angular Momentum quantum number, <em>l</em></th>
<th>Subshell designation</th>
<th>Magnetic quantum number, <em>ml</em></th>
<th>Number of orbitals</th>
<th>Atomic Orbital Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1s</td>
<td>0</td>
<td>1</td>
<td>1s</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>2s</td>
<td>0</td>
<td>1</td>
<td>2s</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2p</td>
<td>-1,0,1</td>
<td>3</td>
<td>2pₓ, 2pᵧ, 2p₂</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>3s</td>
<td>0</td>
<td>1</td>
<td>3s</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3p</td>
<td>-1,0,1</td>
<td>3</td>
<td>3pₓ, 3pᵧ, 3p₂</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3d</td>
<td>-2,-1,0,1,2</td>
<td>5</td>
<td>3dₓᵧ, 3dᵧz, 3dₓz, 3dₓ², 3dᵧ², 3d₂²</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>4s</td>
<td>0</td>
<td>1</td>
<td>4s</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4p</td>
<td>-1,0,1</td>
<td>3</td>
<td>4pₓ, 4pᵧ, 4p₂</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4d</td>
<td>-2,-1,0,1,2</td>
<td>5</td>
<td>4dₓᵧ, 4dᵧz, 4dₓz, 4dₓ², 4dᵧ², 4d₂²</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4f</td>
<td>-3,-2,-1,0,1,2,3</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

*(source: General chemistry TG & Chemistry the Central Science. Brown, et.al., 2015)*
**Guide Questions:**

1. What are the n and l values of 3p orbitals?
   - n= 3, l=0
   - n= 3, l=1

2. What is the ml of the no. 1 orbital?
   - ml= 0
   - ml= -1,0,1

3. What is the maximum number of orbitals of n=4, l=1?
   - 1
   - 3

4. Which orbitals cannot exist?
   - 2d
   - 4p

5. What is the maximum electron pairs that can occupy the subshell of d orbitals?
   - 5 electron pairs
   - 7 electron pair

Since you know already how to use quantum numbers to describe an electron, I guess you are ready to move to the next activity. Come On!

**Activity 4. Representations of Orbitals**

**Directions:** Read the following concept notes and take note of the important points. The learning you get from here will give you the answer to the follow up questions. (2 pts. each)

Wave function provides information about an electron’s probable location in space. Let’s examine the ways in which we can picture orbitals, because their shapes help us visualize how the electron density is distributed around the nucleus.

![Image of orbitals](image)

*Figure 1. Shape of orbitals a.) s orbital, b) p orbital, c) d orbital*

The figures above are simply a representative of the shapes of orbitals. Figure 1a shows the cross-section of 2s. It has a sphere shape. In Figure 1b, this is the shape of p orbital, specifically the px. For the p orbitals, it has a double teardrop shape, or in some books, dumbbell shape. And figure 1c shows the d orbital.

**Shape it!**

**Directions:** With the knowledge on representation of orbitals above, then answer the following questions by shading the circle of the correct answer.
1. What is the shape of the orbital with the quantum numbers \( n=3, l=0 \) and \( m_l = 0 \)?

2. What is the shape of the subshell with the quantum numbers \( n=4, l=2 \) is

3. What is the orientation of the allowed values of \( l=1 \) for the shell \( n=2 \).

In activity 2, 3 and 4, you were introduced to the concept of quantum numbers; its shape, orientation, energy level and spin property which enabled you to describe an electron.

**Activity 5. Electronic Configuration and Orbitals**

**Directions:** Write the electron configuration of the elements in the third period; determine the pattern of filling the orbitals based on the given distribution for the 5 elements. Write your answers on the space provided inside the table.

**Procedures:**
1. Write the electronic configurations for the first 4 elements in the third period of the periodic table. The electronic configuration for Na is already done for your guidance.
   (Note: \( _{11} \text{Na} \) means element Sodium with an atomic number of 11.)
   Atomic number is the number of proton = the number of electron for an atom.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>O</th>
<th>R</th>
<th>B</th>
<th>I</th>
<th>T</th>
<th>A</th>
<th>L</th>
<th>Electronic Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>( _{11} \text{Na} )</td>
<td>1s</td>
<td>2s</td>
<td>2p(_x)</td>
<td>2p(_y)</td>
<td>2p(_x)</td>
<td>3s</td>
<td>3p(_x)</td>
<td>3p(_y)</td>
</tr>
<tr>
<td>1. ( _{12} \text{Mg} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. ( _{13} \text{Al} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. ( _{14} \text{Si} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. ( _{15} \text{P} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. ( _{16} \text{S} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**What is it**

**Quantum Numbers**

The quantum numbers are used to determine the electron configuration of an atom and the probable location of the atom’s electrons. These numbers also used to understand other characteristics of atoms, such as ionization energy and the atomic radius.

The first quantum number, the *principal quantum number*, \( n \), can have positive integral values 1, 2, 3, . . . . As \( n \) increases, the orbital becomes larger, and the electron spends more time farther from the nucleus. An increase in \( n \) also means that the electron has a higher energy and is therefore less tightly bound to the nucleus. The *angular momentum quantum number*, \( l \)— can have integral values from 0 to \( 1n - 12 \) for each value of \( n \). This quantum number defines the shape of the orbital. The value of \( l \) for a particular orbital is generally designated by the letters \( s \), \( p \), \( d \), and \( f \),** corresponding to \( l \) values of 0, 1, 2, and 3:

<table>
<thead>
<tr>
<th>Value of ( l )</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letter used</td>
<td>s</td>
<td>p</td>
<td>d</td>
<td>f</td>
</tr>
</tbody>
</table>

(Source: Chemistry the Central Science. Brown, et.al., 2015)

Strictly speaking, an orbital does not have a definite shape because the wave function extends to infinity. However, while the electron can be found anywhere, there are regions where the probability of finding it is much higher. Figure 2 shows the electron density distribution of a 1s electron around the nucleus. Note that it does not have a well-defined boundary; the more dots, the darker the shade, the higher the probability of finding the electron in that region. Also note that the probability distribution is spherical. We can draw a boundary surface that will enclose 90% of the total electron density in the orbital as shown in Figure 2a. This will result in a boundary surface diagram of the 1s orbital as shown in Figure 2b.

![Figure 2](image)

**Figure 2.** (a) Electron-density distribution; (b) boundary surface diagram of s orbitals

Figure 2b shows that all the s orbitals are spherical in shape but differ in size, which increases as the value of \( n \) increases. The p orbitals starts when \( n =2 \) for which \( l \) has a value of 1 and \( m_l \) has values -1, 0, +1. Therefore, there are three 2p orbitals: 2px, 2py, 2pz indicating the axes along which they are...
oriented. For the p orbitals, the electron probability density is not spherically symmetric but has a double teardrop shape, or in some books, a dumbbell shape. The greatest probability of finding the electron is within the two lobes of the dumbbell region; it has zero probability along the nodal planes found in the axes. All three 2p orbitals are identical in shape and energy but differ in orientation as shown in Figure 3. The p orbitals of higher principal quantum numbers have similar shapes.

Figure 4 shows the d orbitals occur for the first time when \( n = 3 \). The angular function in these cases possesses two angular (or planar) nodes. Four of the orbitals have the same basic shapes except for the orientation with respect to the axes. The wave functions exhibit positive and negative lobes along the axes and shows zero probability of finding the electron at the origin. The fifth wave function, \( d_{x^2} \), has a similar shape with that of the p-orbital with a donut-shape region along the x-axis.

The third quantum number is magnetic quantum number, \( m_l \). Its integral values between \(-l\) and \( l\), including zero. It describes the orientation of the orbital in space. Lastly, Electron spin quantum number is a quantum number which describes the spin of an electron. It is said that an electron has a spin property that would give rise to magnetic moment. The electrons are paired such that one spins upward and one downward, neutralizing the effect of their spin on the action of the atom as a whole. But in the valence shell of atoms where there is a single electron whose spin remains unbalanced, the unbalanced spin creates spin magnetic moment, making the electron act like a very small magnet. As the atoms pass through the in-homogeneous magnetic field, the force moment in the magnetic field influences the electron’s dipole until its position matches the direction of the stronger field.

Magnetic Property of an Atom

The four quantum numbers are very useful in labelling an electron in any orbital in an atom. In the case of hydrogen, there is only one electron. In the ground state, the one electron of hydrogen will occupy the 1s orbital, the one with the lowest energy. This electron is represented by the set of quantum numbers: \( n = 1, \ell =0, m_l = 0, \) and \( m_s = \frac{1}{2} \) or \(-\frac{1}{2}\). By convention, the set of quantum numbers is written as \((1, 0, 0, \frac{1}{2})\) or \((1, 0, 0, -\frac{1}{2})\). The ms value is important in describing the arrangement of electrons in the atom.
It is possible to represent this arrangement of the electron in hydrogen in terms of the electron configuration or in terms of the orbital diagram. The electron configuration shows how the electrons of an atom are distributed among the atomic orbitals. The orbital diagram shows the spin of the electron. For the electron in the ground state of hydrogen, the electron configuration is given as

\[ \text{1s}^2 \]

The fourth quantum number introduced that an electron has a spin property that would give rise to magnetic moment.

**Rules in Writing the Electronic Configuration:**

**Pauli Exclusion Principle**
In filling up the orbitals, the lower energy levels are filled up first before the higher energy levels. This principle states that in an atom or molecule, no two electrons can have the same four electronic quantum numbers. Consequently, an orbital can contain a maximum of only two electrons, the two electrons must have opposing spins. This means if one is assigned an up-spin (+1/2), the other must be down-spin (-1/2).

Consider the case of He with 2 electrons (see Table 3).

<table>
<thead>
<tr>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
</tr>
</thead>
</table>
| \[ \begin{array}{c}
    \uparrow \\
    \downarrow 
\end{array} \] | \[ \begin{array}{c}
    \downarrow \\
    \downarrow 
\end{array} \] | \[ \begin{array}{c}
    \uparrow \\
    \downarrow 
\end{array} \] |

**Hund’s Rule**
For carbon, the electronic configuration is 1s\(^2\) 2s\(^2\) 2p\(^2\). But the orbital diagram shows three ways in which the last electron can be placed in the orbitals which do not violate the Pauli’s exclusion principle as shown in the following:

First option:

\[ \begin{array}{c}
    \uparrow \\
    \downarrow \\
    \uparrow \\
    \downarrow \\
\end{array} \]

Second option:
Third option:

However, each arrangement provides a different energy value. The one with the lowest energy has the greatest stability. Hund’s rule is the guide in determining the most stable distribution. Hund’s rule: *The most stable arrangement of electrons in the subshells is the one with the most number of parallel spins.*

Based on this rule, the third option is the most favorable arrangement for the electron to attain the greatest stability. In the first option, the presence of two electrons with opposing spins in one orbital results in a greater mutual repulsion than when they occupy separate orbitals. Hund’s Rule is followed in d and f orbitals as well.

Pauli’s Exclusion Principle can be tested by simple observation. Measurements of magnetic properties provide the most direct evidence for specific electronic configurations of elements. Paramagnetic materials are those that contain unpaired electrons or spins and are attracted by a magnet. Diamagnetic materials are those with paired spins and are repelled by a magnet. Any atom with an odd number of electrons will contain one or more unpaired spins, and are therefore attracted by a magnet, thus, can be classified as paramagnetic. For an even number of electrons like helium, if the two electrons in the 1s orbitals had parallel spins, their net magnetic fields should strengthen each other. But experimental results showed that the helium atom in its ground state has no net magnetic field.

This observation supports the pairing of two electrons with opposite spins in the 1s orbital. Thus, helium gas is diamagnetic. Lithium, on the other hand, has an unpaired electron and is paramagnetic. The orbital diagram provides information on the diamagnetic or paramagnetic characteristic of an element.

*Aufbau Principle*

The *Aufbau* principle dictates that as protons are added one by one to the nucleus to build up the elements, electrons are similarly added to the atomic orbitals. The order of filling up the atomic orbitals is from lowest energy to highest energy. Within the same principal quantum number, the order of energies of the atomic orbitals is *s<p<d<f*.

For multi-electron atoms, the general order of filling up orbitals can be diagrammed as follows:

(source: https://lavelle.chem.ucla.edu/forum/viewtopic.php?t=33601)
Now that you are equipped with the rules in writing the electronic configuration, Do the next activity to harness your knowledge from the discussion.

**What’s More**

**Activity 6. Let’s Try this!**

**Directions:** Using the knowledge you have in the previous discussion, Fill in the following table:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>ORBITAL DIAGRAM</th>
<th>ELECTRON CONFIGURATION</th>
<th>PARAMAGNETIC OR DIAMAGNETIC</th>
<th>No. of UNPAIRED ELECTRONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>He</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Li</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Be</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Question:** Which of the 5 elements has the highest magnetic properties (most paramagnetic)? ________________________________

Based on Activity 5 & 6, you recall to write the electron configuration of an element and you were able to determine the magnetic property of an atom and also draw the orbital diagram using the electronic configuration. Do the next activity to add more to your bank of knowledge about quantum numbers, determining the magnetic property and orbital diagrams.

**What I Have Learned**

**Activity 7. A mash up**

**Part A. Directions:** Look at the element on the periodic table. Write the electron configuration, its orbital diagram (of the last electron only found in the highest energy level), and its quantum numbers (based only from the highest energy level electron) and determine its magnetic property.

<table>
<thead>
<tr>
<th>Element</th>
<th>Electronic configuration</th>
<th>Orbital Diagram of the last electron</th>
<th>n</th>
<th>l</th>
<th>ml</th>
<th>ms</th>
<th>Magnetic Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: S</td>
<td>1s² 2s² 2p⁶ 3s² 3p⁴</td>
<td>![3p⁴ orbital diagram]</td>
<td>3</td>
<td>1</td>
<td>-1</td>
<td>-½</td>
<td>Paramagnetic</td>
</tr>
<tr>
<td>1. Sc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Na</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Sr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Part B.** Directions: Based from your answer in part A, describe the electron in an atom using the quantum numbers. (3 pts. each)

*Example:* For S element - The valence electrons in the S element is at the 3rd energy level, in p orbital. Its last electron is found to have px orientation and its spin is downward.

1. 
2. 
3. 
4. 
5. 

---

**What I Can Do**

**Activity 8. Element hunting!**

**Directions:** List down at least 5 things that you see around your household. Check the composition through an internet and take note of the highest percentage that make up that certain material. Then you give its electronic configuration, orbital diagram, and magnetic property. Use the table below as your guide to do this.

<table>
<thead>
<tr>
<th>Element</th>
<th>Application</th>
<th>Electronic Configuration</th>
<th>Orbital diagram</th>
<th>Paramagnetic or Diamagnetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Aluminum</td>
<td>Component of a basin</td>
<td>1s² 2s² 2p⁶ 3s² 3p¹</td>
<td><img src="image" alt="Orbital Diagram" /></td>
<td>Paramagnetic</td>
</tr>
</tbody>
</table>

1. 
2. 
3. 
4. 
5. 

---

**Assessment**

**Directions:** Read and understand each question and select the letter of the best answer from among the given choices then write it in the blank provided.

1. Which of the four quantum numbers determine the energy of an electron in a hydrogen atom and in a many-electron atom?
   A. Principal quantum number
   B. Angular Momentum quantum number
   C. Magnetic quantum number
   D. Electron Spin quantum number
2. What is the total number of electrons that can occupy five d orbitals?
   A. 2  
   B. 9  
   C. 10  
   D. 14

3. Which of the four quantum numbers determine the orientation of an orbital in space?
   A. Principal quantum number  
   B. Angular Momentum quantum number  
   C. Magnetic quantum number  
   D. Electron Spin quantum number

4. Which of the following are the set of values of n, l, and ml for the orbital in the 4d sub shell.
   A. n=4, l= 0, ml= 0  
   B. n=4, l= 1, ml= -1,0,1  
   C. n=4, l= 2, ml= -2,-1,0,1,2  
   D. n=4, l= 3, ml= -3,-2,-1,0,1,2, 3

5. What type of electrons is considered when talking of paramagnetic materials?
   A. Paired  
   B. Unpaired  
   C. Equal  
   D. None of the Above

6. Which of the following is not a set of quantum numbers for an electron in a 3p orbital?
   A. 3,1,-1, ½  
   B. 3,1,0, ½  
   C. 3,1,1, ½  
   D. 3,1,1, -1

7. What is the total number of orbitals associated with the principal quantum number n=3?
   A. 1  
   B. 4  
   C. 9  
   D. 20

8. Which quantum number(s) do 2s and 2p have in common?
   A. n and l  
   B. l  
   C. n  
   D. l and ml

9. The atomic number of an element is 73. The element therefore is diamagnetic. Which of the following statement is correct?
   A. The statement above is true, because its atomic number is 73  
   B. The statement above is false, since atomic number is 73  
   C. The statement above is true, because it is odd number.  
   D. Both A and C

10. Which among the orbital diagrams below belong for atoms with the electron configuration: 1s² 2s² 2p⁵?
   A. 
   B. 
   C. 
   D. 

11. Refer to no. 10, What is the magnetic property of that atom?
   A. Paramagnetic  
   B. Diamagnetic  
   C. Semi- magnetic  
   D. None of the Above
12. What will be the possible orbitals for the principal quantum number \( n=4 \)?

A. s, p, d and f orbitals
B. only an s orbital
C. only s and p orbital
D. only s, p and d orbitals

13. Shown below are portions of orbital of diagrams representing the ground-state electron configurations of certain element. Which of them violate the Pauli Exclusion Principle?

A. A and B only
B. A, B, C and D only
C. A, B, C, D and F only
D. All of the Above

14. Which of the following principles that states “No two electrons in an atom can have the same set of n, l, ml and ms quantum numbers”?

A. Bohr’s Theory
B. Pauli Exclusion Principle
C. Hund’s rule
D. Aufbau Principle

15. Which among the following has the highest energy?

A. 3d
B. 4s
C. 4d
D. 5s

You're almost there. Thank you for doing your best. I hope you enjoyed your tour around this module. To end this up, Do the last activity.

**Additional Activity**

**Activity 9. Wrap it up**

Directions: Your task is to make a video report that explains all about your learnings in the topic Quantum Number. From the beginning until the last topic. The video is 3 mins. max. Just follow the rubrics below. Your output should be sent to this email _________________.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Developing</th>
<th>Standard</th>
<th>Exemplary</th>
<th>Total Pts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>6 Lacks depth limited treatment of assigned topics. Demonstrates limited evidence of research</td>
<td>8 Only some topics are thoroughly discussed and given an in-depth treatment. Shows moderate evidence of research</td>
<td>10 In-depth and thorough discussion of assigned topics. Shows strong evidence of research</td>
<td>/10</td>
</tr>
<tr>
<td>Organization and Clarity of Report</td>
<td>Shows minimum planning; some sections are disorganized and confusing</td>
<td>Show adequate planning, some portions needs clarification and improvement in logical presentation</td>
<td>Very well planned, logical presentation and well understood by the audience.</td>
<td>/10</td>
</tr>
<tr>
<td></td>
<td>Makes use of Visual Aids materials but does not enhance the presentation</td>
<td>Makes use of some Visual Aids materials and enhances the presentation to a limited extent</td>
<td>Visual Aids materials are well done and are used to make the presentation more interesting and meaningful</td>
<td>/10</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td><strong>Presentation Aids</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time management</td>
<td>Takes up more than 5 minutes</td>
<td>Hurriedly finishes before 5 minutes</td>
<td>Finishes within the prescribed time with appropriate pacing</td>
<td>/10</td>
</tr>
<tr>
<td>Speaking Skills</td>
<td>Monotone; speaker seem uninterested in material</td>
<td>Clear articulation of ideas, but apparently lacks confidence with material</td>
<td>Exceptional confidence with material displayed through poise, clear articulation, eye contact, and enthusiasm</td>
<td>/10</td>
</tr>
</tbody>
</table>
Answer Key

Activity 1 Part A

<table>
<thead>
<tr>
<th>Element</th>
<th>Magnetic</th>
<th>Magnetic</th>
<th>Magnetic</th>
<th>Magnetic</th>
<th>Magnetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>He</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Ne</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Se</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>S</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
</tbody>
</table>

Activity 1 Part B

1. The valence electron in the Sc element is at
2. The energy level in the orbital, its electron is at
3. The energy level, p orbital, orientation is
4. The energy level, s orbital, spin is 
5. The energy level, s orbital, spin is 

Activity 4

Activity 5

Activity 6

Activity 2

Activity 3
References


Circular boundary enclosing 90 percent of electron density in a hydrogen atom 1s orbital. From Electron Waves in the Hydrogen Atom, Chemistry LibreTexts, November 2016), Creative Commons Attribution-Noncommercial-Share Alike 3.0 United States License.


Development Team

| Writer: | Shekinah O. Caniedo- Aparmacado |
| Editors: | Margie Lou C. Jacob, Laarni A. Adonis, Kathleen Joy B. Padilla, Joly C. Baradero |
| Reviewer: | Sandy R. Albarico |
| Illustrator: | Shekinah O. Caniedo |
| Layout Artist: | Sandy R. Albarico |

Region IX Hymn

Mi último adiós

Soy yo, querida Patria, yo que te canto a ti. Y oras por todos cuantos murieron sin entrada. Por cuantos padecieron tormentos sin igual. Por nuestros pobres carnes que gritan sin amargura; Por huelverías y risadas, por presas sin tortura. Y ora por ti que vives tu sedentario final. Y cuando en noche oscura se envuelve el cementerio Y sobre tú manto modúa velando a ti. No turbes su reposo, no turbes el misterio. Tal vez acordes oigas de clarín o salterio. Soy yo, querida Patria, yo que te canto a ti. Y andando yo en tumba de todas la olvidada No tenga cruz ni piedra que marque su lugar. Déjale que el hombre, la espina, te asista. Y mis cenizas. Sí, que mañana resplandezca. El polvo de la alfombra que vayan a formar. Entonces nada importa me pongas en olvido, Tu atmósfera, tu espacio, tus valles cruzaré. Aroma, luz, color, aroma, cantar, grito, Constante repitiendo la esencia de mi fe.

Mi patria idolatrada. Sí, por sus dos orillas. Miró al cielo, ardiente vivo anhelo, Y cuando ya mi tumba de todas olvidada No tenga cruz ni piedra que marque su lugar. Déjale que el hombre, la espina, te asista. Y mis cenizas. Sí, que mañana resplandezca. El polvo de la alfombra que vayan a formar. Entonces nada importa me pongas en olvido, Tu atmósfera, tu espacio, tus valles cruzaré. Aroma, luz, color, aroma, cantar, grito, Constante repitiendo la esencia de mi fe.

Mi patria idolatrada. Sí, por sus dos orillas. Miró al cielo, ardiente vivo anhelo, Y cuando ya mi tumba de todas olvidada No tenga cruz ni piedra que marque su lugar. Déjale que el hombre, la espina, te asista. Y mis cenizas. Sí, que mañana resplandezca. El polvo de la alfombra que vayan a formar. Entonces nada importa me pongas en olvido, Tu atmósfera, tu espacio, tus valles cruzaré. Aroma, luz, color, aroma, cantar, grito, Constante repitiendo la esencia de mi fe.

Adiós, Patria adorada, región del sol 
quedas. Pura la de mi corazón, nuestro perdido 
保安! A donde yo anhelo la triste muda vida, Y fuera más infante, más fresca, más 
floriz; También por la diosa, la dama por tu bien. En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; El héroe nada importa, cínico, laurel o olivo, Caballo o campo aldeano, combate o cruzar mítico. Y en mi mano el polvo que la patria y el hogar. Yo muerto cuando veo en el cielo se colora Y al fin un día... el mar de olvido capaz; A alcanzar cruceros para teñir tu aurora, Veinte la sangre mía, derrámala en buen hora Y obtiene un reflejo de su naciente luz Mi sueño alrededor apresa mudeza abrumadora, Mis sueños cuando voy a morir se desvanezcan, Fueron el verte un día, joya del mar de olvido, Secos los negros ojos, alta la tersa frente, Fueron el verte un día, joya del mar de olvido, En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros te dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir. Morir por darte vida, ¡Salud te grita el alma que pronto va a partir! En campos de batalla, luchando con delirio, Otros la dan sus vidas sin duda, sin pesar; En tu encantada tierra la eternidad dormir.